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Continuous improvement: A study of team maturity to support progression dynamics

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General introduction

Decades after the emergence of the Continuous improvement (CI) concept and its revolutionary impact in the industrial landscape, this apparently straightforward and intuitive quality management philosophy remains difficult to implement successfully across organizations.

The problem with implementing CI persists despite numerous well-documented successful cases of CI programs. Toyota, a precursor and still its most influential proponent, remains a distant inspiration for companies. On the surface, CI appears simple, but it is actually a high mountain to climb, sometimes high enough to keep organizations from getting to it.

In fact, the majority of CI programs are reported to fail (McLean *et al.*, 2017). For example, only 10% of organizations manage to sustain Lean initiatives (Lopes *et al.*, 2023). In this light, if the technical aspects of CI are well-established, supported by years of research and various tools to guide practitioners, the underlying issue likely resides in another fundamental pillar.

Considering the Toyota Production System (TPS), the most prominent example of CI success, the title of its first academic mention, published by Sugimori *et al.* in 1977, offers a clue to the riddle: a Respect-for-Human system.

CI is referred to as people-oriented (Berger, 1997). People are at the center of the initiative, which demands their proactive engagement. From this angle, to engage humans in CI, particularly those within production lines, is the foundation to sustain improvement.

In this sense, literature emphasizes the role of CI managers in attaining this goal. For instance, the book "The Toyota Way to Lean Leadership" (Liker & Convis, 2011) delves into the self-development journey of leaders to achieve and sustain excellence in CI initiatives. A CI manager encourages employees to improve processes, emphasizing how the changes make their jobs easier, while measuring and documenting these impacts to continuously promote CI (Wiseman, 2011).

In the same vein, a core aspect of CI programs is training the workforce to effectively apply improvement concepts and tools, enabling them to identify, analyze, and minimize waste in production processes. Training programs are designed through traditional methods, such as lectures, as well as active learning methods, and are intended for individuals or teams.

The successful application of CI tools requires employees to work in teams and engage multiple stakeholders, meaning the workforce must navigate a variety of interactions and be able to effectively communicate with these stakeholders (Wiseman, 2011).

In this sense, efforts to address the human aspect crucial to CI have included management practices and training programs. Yet, the persistent failure of these initiatives suggests that either the existing approaches, despite extensive documentation, are not being effectively implemented, or the current

methods are insufficient, revealing an opportunity to reimagine strategies and tackle these persistent issues.

When it comes to the human element, there is no universal formula of leadership and training that can guarantee success in consistently engaging the workforce to sustain CI. Engagement involves more than just technical or interpersonal skills that can be taught; it is rooted in complex human dynamics. These dynamics, which are essential for CI to thrive, are shaped by a variety of factors that are not always easily translated into clear actions. Additionally, as with any human development process, these dynamics cannot depend solely on external actions from managers or training programs; they must also be driven from within.

On the other hand, effectively addressing this issue demands a practical approach that can be applied in real-world settings - otherwise, purely theoretical or overly idealistic solutions are unlikely to result in meaningful change.

In this light, this thesis aims to contribute to a critical challenge faced by organizations on a CI journey, which is "**How to engage the workforce in a CI dynamic to support initiatives?**".

From this perspective, considering that CI relies on the collective effort of individuals striving for improvement through team practices, and acknowledging the mutual influences between individuals, teams, and their environment, an effective approach lies in selecting the team as the strategic angle to foster workforce engagement.

Moreover, given that the dynamics required to support CI go beyond basic teamwork or skills that can be taught through training, a more fitting subject of study is team maturity. The concept of maturity captures the interplay between actors and their environment, not limited to isolated actions but encompassing the relational and contextual dynamics that influence them.

Therefore, understanding the key elements of team maturity required to sustain CI initiatives can help clarify the factors that drive it, paving the way for practical strategies to foster team maturity and ensure the long-term success of CI programs. In this context, engaging teams into a CI dynamic through maturity assessment and subsequent development emerges as a strategic solution. Assessing team maturity provides a foundation for targeted evaluations, with the resulting measures guiding the creation of tailored improvement plans.

Altogether, while recognizing that team maturity cannot be imposed externally and must also be driven from within - demanding that actors actively engage in their own maturity process - this practical approach avoids the unrealistic expectation that teams will mature independently, especially since CI remains an organizational objective. However, a team-maturity-centered approach, and highlighting its mutual benefits - such as enhanced team member satisfaction and well-being within a mature team environment - can motivate teams to take ownership of their own maturity journey.

Expanding on these ideas, this thesis is structured into an introduction, 4 chapters, and a general conclusion. Each chapter explores a specific aspect of the discussion, with each one building on the previous and paving the way for new objectives.

The first chapter addresses the general question: **"What approach can support progress dynamics in the CI field?"**. To this end, it examines CI initiatives, offering an overview of their origins, associated challenges, and human dimension. The chapter reviews existing literature on the workforce within the CI context, identifying current practices and knowledge gaps to propose an approach that can contribute to the integration of the workforce into the CI dynamic. It concludes by defining team maturity as a holistic approach to determining if a team can sustain CI initiatives and outlining the specific objectives that follow.

In this sense, when it comes to supporting the CI dynamic, questions arise: what should be measured? Which performance? Since the aim is to move beyond existing performance metrics, the second chapter focuses on identifying team maturity in the CI context, to translate this approach into practice.

Therefore, **the second chapter** examines the question: **"What are the characteristics of mature teams in CI contexts?"**. To respond to this, it conducts a thorough investigation of team maturity in both general and CI-specific contexts, drawing on 2 Systematic Literature Reviews and insights from CI experts. It concludes with a team maturity characterization specifically adapted for production teams within CI environments.

Building on this foundation, a measure of team maturity can begin to be envisioned, emerging from the dynamics of teams within the CI context, which raises further questions about "What objectives or standards should this measure be compared to?", and, subsequently, "How can maturity be evaluated in relation to these standards?". Once this measure is established, the focus shifts to: 'What actions can be implemented to support progress dynamics?".

In this sense, **the third chapter** addresses the critical questions: **"How to assess the maturity of CI production teams?"** and **"How to further support the development of tailored team maturity improvement plans?"**. To answer these, it proposes a Conceptual Team Maturity Improvement Process to encapsulate this approach, focusing on the assessment and improvement of team maturity. It develops a team maturity model and proposes an assessment method based on the evaluation of team maturity by all team members. It also identifies key axes of intervention and the factors influencing team maturity, which can guide the creation of tailored improvement plans.

Finally, **the fourth chapter** aims to bridge the gap between the theoretical concepts developed throughout the thesis and their **practical application**. It employs a case study methodology to evaluate the feasibility and effectiveness of the team maturity model and assessment approach, in real-world CI settings. It includes the development of a maturity assessment questionnaire, followed by the reporting and analysis of 2 case studies, each involving the maturity assessment of several teams within their respective organizations. This method provides insights into the viability of the team maturity approach, the refinement of an assessment protocol, and its potential to integrate teams into a continuous improvement cycle.

The thesis concludes with an overview of its contributions, followed by a discussion of its limitations and suggestions for future research.

Chapter 1

CI dynamics and a human-centered maturity approach

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Continuous improvement (CI) has accumulated an extensive body of literature over the years, including best practices, success factors and implementation strategies. Despite this, organizations continue to face numerous challenges in their CI efforts, and no single methodology guarantees success. On the other hand, the success of these initiatives is reported to depend on the appropriation of its methods by the workforce and their active engagement.

In this sense, an investigation is conducted into CI initiatives, followed by a focus on its human side and aspects that remain perhaps overlooked. The objective is to explore the current state of the art on CI initiatives and the role of the workforce, highlighting key aspects and opportunities to delineate an approach that can engage the workforce into the CI dynamic.

This chapter is organized as follows: Section 1.0 traces the evolution of CI programs, outlining success factors and obstacles organizations encounter in sustaining their initiatives, as well as its human factors and how they are currently addressed. Section 1.2 investigates the workforce within these settings, highlighting the contributions of individuals and the pivotal role of production teams. Section 1.3 introduces a maturity lens, establishing its relevance to the CI context and the human issue under consideration. Finally, Section 1.4 synthesizes these findings and proposes a team maturity approach to support sustainability of CI initiatives. The chapter concludes with an outline of the research objectives.

1.1. Continuous improvement

1.1.1. CI origins

The Continuous improvement (CI) concept was officially introduced by W. Edwards Deming, as one of the 14 points for management presented in his book “Out of the Crisis” (1982), which states: “*improve continuously and forever the system of production and service to improve quality and productivity*”. Considered the father of Total Quality Management (TQM), the mathematical physicist made groundbreaking contributions on process stability and predictability, and statistical control. Furthermore, he revolutionized the management practice through his view of quality from a systems perspective (Madu, 1998).

After World War II, Deming was invited to Japan to lecture on his quality philosophy, drastically impacting the japanese manufacturing scenario at that time. Inspired by his words, a famous japanese management professor, Kairo Ishikawa, promoted his speech, which subsequently led to Deming’s words being put in practice by Kiichiro Toyoda, the president of Toyota Motor Company (Madu, 1998). The rebirth of the japanese industry is explained by Masaaki Imai in “The Key to Japan’s Competitive Success” (1986). The book delves into the country’s successful quality journey, featuring the Toyota Production System (TPS) and highlighting a deeply rooted practice of incremental improvement denoted as Kaizen.

Later, exploring the principles behind TPS and a pull-based production system called Just-in-Time (JIT), northern-american authors published "The Machine That Changed the World" (Womack *et al.*,

1990) and introduced Lean Manufacturing (LM), a globally recognized production philosophy to maximize value and minimize waste.

Moreover, around 1987, Motorola developed a new management strategy to counter the severe japanese competition threatening to drive them out of business. Six Sigma was responsible for the company's impressive turnaround, and is aimed at reducing defects and process variability through a data-driven approach guided by a DMAIC model (Define, Measure, Analyze, Improve, Control) to drive continuous process improvement (Pande *et al.*, 2000).

The quality management movement initiated in the 1980s also culminated in the launch of ISO 9000 series by the International Organization for Standardization (1987). Since its creation, the global regulatory framework guides organizations towards a structured Quality Management System centered on process orientation and continual improvement. The standard is continually updated (1994, 2000, 2008, and 2015) to incorporate new concepts and expand its applicability to emerging industry sectors, but its core principles have remained unchanged.

Since its origins, the number of CI initiatives in the industry has consistently increased, and interest in them continues to grow in an increasingly competitive industrial scenario. **These days, organizations must aim for a sustainable level of operational excellence, achieving a balance between high quality standards, strong industrial performance and the capability to adapt fast** (Carvalho *et al.*, 2023)**.**

1.1.2. CI initiatives

Bhuiyan and Baghel (2005) traced the evolution of CI and demonstrated that some companies in the 1800s had initiatives aimed at work improvement, such as incentive programs, but modern CI, which started after the TQM movement, is associated with organized and comprehensive methodologies. They argued that these CI programs have since evolved from its traditional manufacturing roots with systems focused on the production line, into comprehensive, systematic methodologies that focus on the entire organization, from top management to shop floor workers.

For Madu (1998), CI is a management philosophy that emphasizes a perpetual process of improving machinery, labor, products and processes. In CI management, progress, regardless of the scale, can always be achieved through the use of tools and techniques aimed at identifying and resolving problems, and minimizing waste and variations (Singh & Singh, 2015). CI implies organizational change through the application of an adapted strategy. For instance, one of the tactics recommended by ISO 9001 is a PDCA cycle (Plan, Do, Check, Act) to integrate quality management to operational processes and support continual improvement (Majerník *et al.*, 2017).

Moreover, CI serves as an engine for widely adopted quality systems such as TQM, LM, Six Sigma and Kaizen (Sanchez & Blanco, 2014), and it is a premise in employee involvement's campaigns or waste reduction efforts (Singh & Singh, 2015). Concerning the aforementioned famous methodologies, the

in-depth research of Chirinos (2018) noted their mutual alignment to a CI cycle and pointed out significant shared traits:

- They use strategies linked to the highest levels of management and require participation of all members of the organization;
- Their endeavor to maintain a CI dynamic is based on constant changes;
- They possess standardized processes that make learning formal and orderly;
- They are highly focused on improving process performance;
- Their value orientation includes the constant search for customer satisfaction (internal or external customer).

These are basic traits for CI programs, and in practice the implementation of even the same methodology can vary across firms. Each company customizes its quality system by selecting the tools and procedures that align best with its specific context and needs. Besides, some companies merge different CI methodologies together to overcome the limitations of one specific program (Bhuiyan *et al.*, 2006). For instance, Lean Six Sigma stands as the most well-known hybrid methodology, integrating principles from both LM and Six Sigma (Bhuiyan & Baghel, 2005).

In this context, CI initiatives can be interpreted here as all quality efforts that rely on the CI philosophy and partake in these fundamental traits. In a corroborating manner, Bhuiyan and Baghel (2005) noted that the literature often refers to CI as an umbrella term that incorporates attributes from various quality initiatives.

For Rijnders and Boer (2004), CI is not as a single construct, but rather a collection and progression of various concepts that should be carefully selected, as they can be difficult to integrate with other daily activities. The authors developed a typology framework for the numerous approaches of CI implementation, thus illustrating its complexity. Their framework stressed common themes among these different approaches, which were here interpreted to form basic guidelines for generic CI transformations:

- A formalized implementation structure and the use of more concrete CI concepts (concepts with more practical detail) increase success rate;
- Not to underestimate time and effort necessaries to learn about CI and CI implementation, it is imperative to communicate the CI message intensively and repeatedly;
- Direct transference from a few experts to the entire organization works better than having each hierarchical level train the level below it;
- Ineffective communication lines and tensions between management and workforce hinder the CI transaction process, or how CI flows across the organization.

As observed, CI programs are not simple endeavors; they require structure, open communication channels at all organizational levels and a full commitment of all staff to CI practices. In this context, many authors have studied critical success factors, characteristics or enablers related to CI transformations. Some recent works include Gastelum-Acosta *et al.* (2022), who proposed the critical

success factors for manufacturing companies implementing a CI program. They conceived and validated an instrument to evaluate the degree of compliance to these factors, which are as listed:

- Participation and commitment of top management;
- Training and education;
- Prioritization and selection of projects;
- Cultural change;
- Linking with human resources;
- Leadership management;
- Communication;
- Teamwork;
- Linking with suppliers.

Furthermore, scholars have directed their attention towards the deployment of CI initiatives, establishing frameworks to characterize stages of CI implementation. Bessant *et al.* (2001) view CI as an organizational capability built through an evolutionary process of behavior and routine development. Their research proposes maturity levels for CI programs, with their associated practices, performance outcomes, as well as the evolving pattern of behavior and routines through each level. Chirinos (2018) also proposed a maturity model for CI programs, with an instrument that assesses its stage of implementation, from initiation to a perpetuation state of continual improvement, as well as the disparity or parity of the program, that indicates if different sustainability characteristics are at the same level of implementation.

Chirinos (2018) highlighted the paradoxical nature formed by the merger of both concepts: sustainability and continuous improvement. He determined that sustainability within the CI frame is in a constant dynamic that evolves between stable and fluctuating states. In addition, he listed 16 elements constituents of this dynamic, or elements capable of characterizing the sustainability of CI programs, which he classified into 5 groups:

- Initiators: Culture, Workforce Engagement and Training;
- Support and Execution: Resources, Methods and Tools and Organizational routines;
- Management process: Communication management, Time management, Change management, Risk management and Knowledge management;
- Performance management: Diagnostics, CI key performance indicators, Decision-making and CI performance.
- Leadership.

Overall, companies aspire to transform into quality organizations, and that requires devotion and commitment (Madu, 1998). **From following basic guidelines to identifying key success factors for implementation, evaluating system deployment, and ensuring its sustainability, companies face numerous challenges in translating these initiatives into effective practice.**

1.1.3. CI challenges

After nearly 4 decades of CI endeavors and extensive research, CI remains a challenging initiative for organizations. In fact, the majority of these programs are reported to fail (McLean *et al.*, 2017). CI initiatives become failures when the projected financial, organizational, operational or social objectives are not attained (Shokri *et al.*, 2022).

Lean Management (LM), one of the most conducted CI methodologies (Sanchez & Blanco, 2014; McLean *et al.*, 2017), is stated to be difficult to implement successfully (De Vries & Van der Poll, 2018), with less than 10% of the organizations being able to maintain it over time (Lopes *et al.*, 2023). As for TQM, the success rate in Europe is reported to be between 10% and 30% (McLean *et al.*, 2017). Against this background, the review effort of McLean *et al.* (2017) brought together the themes responsible for CI implementation failures in manufacturing settings:

- Initiating programs for the wrong motives and false expectations of the outcomes;
- Failing to change the organizational culture or environment;
- Lack of management commitment and support;
- Implementing programs partially or too rapidly, without dedicating the time to anchor changes properly;
- Unadapted or non-existent training, or insufficient education levels caused by high level of turnover or other factors;
- Poor selection of projects and lack of resources;
- Insufficient levels of employee involvement;
- Distorted feedback or inaccuracies leading to false interpretation of results.

Moreover, the more recent research of Bader *et al.* (2023) updated the investigation of McLean *et al.* (2017) and focused on examining empirical evidence, while also including the service sector. They found previously unreported failure factors, including the absence of a sustainability approach and work safety concerns. Still, the paper identified resistance to change from employees as the main contributor to CI failure, followed by insufficient management support and inadequate training.

CI results can take time and be perceived as a waste of time and money by management that may decide to abandon the effort (Bhuiyan *et al.*, 2006). According to Bader *et al.* (2023), the success or failure of a CI program depends on a strong and persistent organizational motivation for its implementation. Therefore, they studied change management theory to propose a mitigation framework, in which they establish recommendations for planning, implementing and sustaining CI initiatives:

- Planning: people naturally resist change, so individuals must be convinced that changes are crucial and beneficial. There must be serious motivation before undergoing change. Management has to create awareness, communicate the vision and inspire feelings of satisfaction. Multidisciplinary teams in terms of complementary skills and experience should assist in achieving expected outcomes.

- Implementing: a proper selection and structured application of tools is essential. Management must provide resources and training empowering employees to act on the improvement vision. Generating short-term wins through easy-to-implement tools is motivating for the long term, to acknowledge good work and progress increases both management and workforce commitment. Companies should adopt a set of frequent assessment indicators for continuous monitoring and evaluation mechanisms.
- Sustaining results: to build on short-term gains to succeed in implementing more complex projects next, ensuring continuity. Reinforce the CI culture through performance metrics and recognition feedback, embedding assessments to regular activities.

As evidenced, CI initiatives rely heavily on employee involvement levels, with the most significant barriers for a successful and sustainable implementation being human-related (McLean *et al.*, 2017; Lopes *et al.*, 2023; Bader *et al.*, 2023).

Altogether, after decades of practical and theoretical progress in the field, the work of Bouranta *et al.* (2021) points to human-related factors as the key to understanding why CI programs often fail in a lot of firms. Indeed, the authors highlighted the great number of empirical studies carried worldwide in manufacturing and service industries, involving organizations of all sizes in both private and public sectors, but mainly focused on hard practices, while neglecting the essential role of soft practices and human-related factors in successful implementations. Their literature review indicated a recent interest in these factors; **however, few studies thoroughly examined the human-related contribution in CI programs, leading to a limited understanding of the subject and hindering further advancements.**

1.1.4. CI and human-related factors

CI initiatives are often launched by qualified project leaders with the support of improvement specialists and teams, but they rely on the alignment, acceptance, change and experience of all employees (Lameijer *et al.*, 2021). Therefore, in successful CI transformations, the workforce is not only responsible for performing predetermined actions, but it is also the source of improvement (Lopes *et al.*, 2023).

Many studies highlight the impact of human-related factors on the success and sustainability of CI transformations (McLean *et al.*, 2017; Bouranta *et al.*, 2021; Lameijer *et al.*, 2021; Bader *et al.*, 2023; Lopes *et al.*, 2023). In a similar manner, previous research indicates that embedding CI into the organizational culture is crucial for its prosperity (McLean *et al.*, 2017; Bader *et al.*, 2023; Lopes *et al.*, 2023; Carvalho *et al.*, 2023).

For Haffar *et al.* (2019), ignoring the strategic value and role of employees leads to fiascos in TQM implementation, since they must be prepared to embrace change and innovation. Furthermore, based on a survey of 80 companies across various sectors in France, Chirinos (2018) found that employee engagement emerged as the foremost determinant element of the sustainability of CI programs.

Regarding LM implementation, the extensive research of Bortolotti *et al.* (2015) covered 317 manufacturing facilities across 10 countries, confirming that successful transformations were characterized by in-group collectivism and human orientation, where individuals express cohesiveness and are encouraged and rewarded for being fair, altruistic and generous. Moreover, the paper revealed that soft practices, such as small group problem solving are essential in the CI process and prosperous facilities implemented them extensively.

For Tortorella and Fogliatto (2014), the human dimensions of motivation, empowerment and respect for people are important drivers of CI success. In fact, the theoretical background concerning CI environments underlines that it improves work culture and harnesses the participation of workers, supporting personal growth, while gathering competencies through adequate training and skill diversification (Singh & Singh, 2015).

Moreover, employee involvement and creativity are encouraged and their suggestions improve working conditions and simplify tasks, thus promoting favorable attitudes and generating satisfaction among workers (Bhuiyan *et al.*, 2006; Singh & Singh, 2015). Nevertheless, there is also evidence that the structure of CI settings can limit autonomy and reduce work motivation, innovativeness and well-being (Lantz *et al.*, 2015).

Researchers fear that the working conditions in CI contexts lead to negative employee outcomes instead, due to work intensification (Huo & Boxall, 2018; Neirotti, 2020) and pressure to meet quality standards (Neirotti, 2020). In light of this dilemma, the studies of Huo and Boxall (2018) and Neirotti (2020) demonstrate that CI can have positive or negative outcomes for workers. **The crossroads lies in implementing it at a mature and systemic level that favors its positive potentials and reduces its negative effects on the workforce.**

1.1.5. CI and the deficiency of human-related assessments

According to (Hernandez-de-Menendez *et al.*, 2020), a major challenge arising from technological advancements is ensuring that the workforce possesses the necessary skills. They argue that professionals must engage in continuous learning, and organizations must actively monitor their progress, in light of ongoing industry evolution. Companies employ diverse methods to assess skills and ensure effective training, including certification programs, classroom instructions, practice centers, learning factories and augmented reality. Nevertheless, when it comes to assessing soft skills, industries often rely solely on psychological tests, which may not fully capture essential aspects such as resilience, determination, excellence, self-discipline, curiosity, independence, and creativity (Hernandez-de-Menendez *et al.*, 2020).

CI is people-oriented: people are at the core of the initiative, which necessitates their proactive engagement (Berger, 1997). Yet, there is not sufficient empirical evidence regarding human-related factors in CI implementation (Bouranta *et al.*, 2021) and the point of view of the workforce is overlooked in CI literature (Colazo, 2020). This scenario limits the prospects of driving the human performance level necessary to support CI programs.

In quality management, a popular maxim asserts that "you cannot improve what you do not measure". Yet, applying this principle to individuals sparks debate about the impact of assessments on their performance. A theoretical stream suggests that assessing workers may upset their motivation and initiative (Manz & Sims, 1987), which can be particularly detrimental in a CI environment. From this viewpoint, the investigation of Ingvaldsen and Benders (2016) concluded that there is no sufficient evidence that CI settings are associated with a particular control span and, although close supervision is stigmatized, the real issue is more likely related to authoritative supervisory behavior rather than close supervision.

In light of this, individual or group assessments are not inherently harmful. Instead, it is sufficient to return to one of the pillars of the Toyota Way, alongside continual improvement: respect for people (Womack & Womack, 2011). Drawing from a decade of observations, Womack and Womack (2011) advised companies to examine their purposes, processes and people, in that order. Still, he clarified that by "process" he was referring to all of the steps, mostly human actions, required to deliver value to customers. He emphasized that this assessment approach demands considerable effort, as it is focused on comprehension over merely control of the workforce through simple metrics concerned only with results.

The case study presented by Wang *et al.* (2016) demonstrates that quantitative evaluation should be regularly conducted on teams regarding operations, safety, quality and talent development. The concrete program depicted by the authors achieved impressive performance and innovation through workforce management that improved efficiency and individual skills. Although evaluation criteria were not fully disclosed, their objectives included cultivation of teamwork, abilities to inspect problems, information collection and feedback, and developing a quality consciousness. Their evaluation system helped teams to understand their weaknesses and consciously develop measures to reform and improve, thus serving as reference for other companies.

Berlec et al. (2017) proposed and tested a model to assess Lean learning of managers and employees using interview guides after each step of a LM implementation plan. Their model emphasized the growth of knowledge, management support and communication, which should increase following each implementation step. Their assessment allowed companies to monitor and react to early signs of poor knowledge or lack of management support, which are both critical for CI programs.

The practices of workers meant to support CI initiatives are often categorized as results of their soft and hard skills (Lista et al., 2022). Soft skills encompass personality traits that define how an individual behaves in a professional setting; they are intangible elements and interpersonal aspects (Hernandez-de-Menendez *et al.*, 2020; Lista *et al.*, 2022). In contrast, hard skills refer to knowledge or technical capabilities, and the literature related to CI education and training is far more concentrated on their development, while soft skills - which are more challenging to transmit - are neglected (Lista *et al.*, 2022).

Carvalho *et al.* (2023) demonstrated that organizations focused on the cultural side of operational excellence and its soft factors achieve more success in implementing principles and practices over the years. **In this sense, the lack of attention given to soft factors** (Bortolotti *et al.*, 2015**;** Bouranta *et al.*,

2021**;** Lista *et al.*, 2022)**, as well as assessments that fail to capture the dynamics of the workforce in a CI setting, and to provide a comprehensive viewpoint, represent a setback that restricts the enhancement of human contribution, and therefore hinders CI programs.**

1.2. The workforce in Continuous improvement contexts

1.2.1. Individual CI behaviors

A CI initiative involves more than just workers applying structured methods; it requires a shift in mindset and behavior focused on continual improvement (Van Dun & Wilderom, 2016). The research of Jørgensen *et al.* (2007) confirmed that employees carrying out CI activities have a key role in increasing company performance. They support strategic objectives through CI, enhancing productivity, administrative routines and other performance measures.

CI behaviors concern all activities performed with the aim to continuously improve operations and performance of the organization (Jørgensen *et al.*, 2007). In this sense, Bessant and Caffyn (1997) determined that a successful CI implementation can be depicted through the accumulation of behaviors and routines of individuals, groups and the organization. The individual behaviors that support successful implementation include a holistic view of the organization and understanding of strategic objectives to select activities, application of improvement methods, such as problem-solving and process measurements, learning from past experience, sharing knowledge with others and explaining failures without blaming co-workers.

Additionally, Jørgensen *et al.* (2005) identified essential skills of workers and middle managers in CI contexts. These included: knowledge, the application of tools, project management, team skills, leadership and several personal attributes, such as motivation, high energy levels and ability to see opportunities. In a more recent study, Dillinger *et al.* (2022) proposed workforce requirements for integrating LM methods with Industry 4.0 technologies, highlighting the importance of general traits such as personal responsibility and initiative, along with specific skills such as the ability to modify, develop or manage interfaces effectively.

Most notably, Jørgensen *et al.* (2007) examined extensive data from a survey aimed at exploring and following the evolution of practices of companies implementing CI. The survey was developed by an international consortium encompassing 543 manufacturing companies in 11 countries located in Europe, Asia and Oceania. Based on the behaviors' descriptions offered by Bessant and Caffyn (1997), the authors detected 20 CI behaviors of employees that support CI programs:

- Aligning CI to strategies;
- Learning from experience;
- Understanding strategic goals;
- Responding to improvement ideas;
- Sharing of learning;

- Measuring CI results;
- Seeking opportunities for training and development;
- Participating in CI;
- Incorporating learning into work processes;
- Having customer-oriented behaviors;
- Using formal problem-solving tools and techniques;
- Feeling process ownership;
- Using improvement tools;
- Measuring CI process;
- Broad involvement;
- Customer-involvement in CI activities;
- Adjusting the improvement system;
- Explaining failures without blaming individuals;
- Working across divisions;
- Incorporating customer feedback.

The results achieved by Jørgensen *et al.* (2007) also demonstrated that management mechanisms such as measurement systems, top management support and learning reinforcement, positively impact these CI behaviors. Furthermore, they found that organizational performance, which encompasses employee commitment and attitudes towards change, safety, well-being, skill development and absenteeism, was found to be most strongly influenced by the adoption of these behaviors. Overall, the authors concluded that CI success depends on knowledge, skills, attitude and availability of resources. They emphasized that workers should not only carry out CI activities, but also extend beyond their immediate scope and make the right choices in doing so.

In a similar manner, Van Dun and Wilderom (2016) suggested that workers' behaviors reflected the values of their leaders. These were self-transcendence values that were positively associated with effectiveness. However, expanding their research, Van Dun and Wilderom (2021) exhibited a reciprocal influence in which workers and leaders maintain and improve high performance levels, endorsing the values of self-transcendence and openness to change. Self-transcendence values emphasized concern for others, while openness to change entailed embracing risk through experimentation and daringness. Aligned with these values, the actors surpassed their individual interests, maintained effective collaboration, continuously enhanced their operations, and secured the necessary resources to support their efforts.

Drawing from the investigation conducted by Bessant and Caffyn (1997), further explored by Jørgensen *et al.* (2007) in his thoroughly extensive research, **it is clear that most individuals' CI behaviors also depend on other group members. These behaviors can involve mutual interaction, be collective efforts, or emphasize a directive of sharing. Moreover, according to** Van Dun and Wilderom (2021)**, workers, middle-level leaders and high-level leaders continually influence each other's behaviors and values.**

1.2.2. Individual readiness for change

A CI initiative entails a fundamental shift in approaching all organizational processes, thus it implies organizational change. In this scenario, scholars have reported the importance of human factors in change implementation efforts, stressing the concept of Individual Readiness for Change (IRFC) as a determinant to whether employees will resist or support an organizational change effort (Armenakis *et al.*, 1993; Holt *et al.*, 2007).

Holt *et al.* (2007) defined IRFC as an individual's attitude toward a particular change, reflecting their cognitive and emotional inclination to accept, embrace, and adopt a particular plan that alters the status quo. Armenakis *et al.* (1993) argued that insufficient level of change readiness is one of the main reasons organizations fail to implement change successfully. This readiness involves individuals' evaluations of the benefits of the change for themselves and the organization, their perceived abilities to implement the change, and their recognition of the necessity for organizational change (Armenakis *et al.*, 1993; Holt *et al.*, 2007).

Change initiatives are carried out by individuals within organizations. Holt *et al.* (2007) conceptualized IRFC as a multidimensional construct consisting of 4 distinct components:

- individuals' confidence in their ability to execute the change or change efficacy;
- management support for the change;
- appropriateness or suitability of the change;
- personal benefit associated with the change.

Addressing each of these components, they developed a 24-item instrument to assess the level of IRFC of the workforce, in order to facilitate strategies to initiate and implement organizational changes more effectively.

In a similar vein, Herscovitch and Meyer (2002) conceptualized Individual Commitment to Change as a mind frame that compels someone to undertake actions necessary for the successful implementation of a change initiative. They identified 3 dimensions of this mindset:

- a desire to support the change based on belief in its benefits, named affective commitment to the change (IACC);
- recognition of the costs associated with not supporting the change, named continuance commitment to the change;
- a sense of obligation to support the change, named normative commitment.

IRFC is acknowledged as a critical predictor of organizational members' IACC (Holt *et al.*, 2007; Naseer *et al.*, 2023). Together, high levels on both measures have been demonstrated to positively influence the implementation level of TQM practices (Haffar *et al.*, 2019). Regarding IRFC particularly, many studies have emphasized its impact on the success of TQM programs (Haffar *et al.*, 2013; Haffar *et al.*, 2019) and Iqbal and Asrar-ul-Haq (2018) found that TQM practices have minimal impact on

employee performance, unless employees are prepared to accept and implement the changes imposed by the new practices.

Haffar *et al.* (2019) emphasized that individuals who are psychologically prepared for change are more positively disposed to TQM implementation. Their findings supported the multidimensionality of IRFC proposed by Holt *et al.* (2007), concluding that the significance of different IRFC components varies depending on the type and context of the change. In the Algerian manufacturing specific context, personal benefit and change self-efficacy were the most supportive IRFC dimensions for TQM implementation, even if all 4 dimensions were considered important to change initiatives.

In addition, Haffar *et al.* (2013) found that organizational culture strongly influences IRFC, which in turn impacts TQM implementation. Their research, which covered about 350 Syrian manufacturing organizations, demonstrated the direct influence of IRFC on TQM implementation and that individuals were more likely to exhibit higher levels of readiness for change when they perceived their work environment as embodying traits of adhocracy and group culture. Adhocracy culture is noted by its active, energetic, and innovative nature that promotes flexibility and the encouragement of new ideas, while group culture emphasizes collaboration, cohesion and participation.

Moreover, Allaoui and Benmoussa (2020) examined employees' attitudes in a LM implementation process in the public sector and concluded that the people who accepted the change process were motivated by individual, organizational and group factors. Individual motivators included dissatisfaction with working conditions, interest in the project and curiosity, while organizational motivators encompassed a positive relationship with management. Lastly, the authors found 2 group motivators: good relationships with work colleagues and their positive influence on employee choices.

As observed, the antecedents that determine workers' readiness for change can be assessed through the IRFC, which has shown to be adapted to CI contexts (Haffar *et al.*, 2013; Iqbal & Asrar-ul-Haq, 2018; Haffar *et al.*, 2019). **However, this construct focuses on individual readiness in isolation from their group dynamics. In this sense, the group an individual belongs to can serve as a motivator or detractor, and act as either a catalyst or a barrier to change.**

1.2.3. Team role in CI initiatives and amplifying individual contribution

From a strategic standpoint, while individual contributions to performance are notable, teams should be the primary focus of change efforts (Al-Sabbagh & Gren, 2018). Moreover, Womack *et al.* (1990) hold teams as the essence of CI and values and practices like teamwork and communication as crucial for its success. The research of Lopes *et al.* (2023) highlighted the essential role of teams and the critical success factors for sustaining CI programs over time:

- Cross-functional teams;
- Team understanding of improvement goals;
- Knowledge sharing;

- Project team selection;
- Teamwork.

For Giedraitis *et al.* (2017), as the potential of team members expands and their relationships are reinforced, the organization experiences escalated outcomes due to a synergistic effect. Moreover, the readiness of the workforce to function as a productive team in the long term is not defined by the sum of their skills, and Easton and Rosenzweig (2012) found no relation between individual experience and project success. Based on the aforementioned, considering employees in isolation, while overlooking the group unit and their interactions within it, is insufficient for a sustainable CI strategy.

Grant and Hallam (2016) stressed the importance of encouraging teams into setting priorities, developing their collaboration and promoting adaptable team structures that facilitate their adjustment to the CI system for successful implementations. Likewise, De Vries and Van der Poll (2018) argued that LM initiatives require team formations. They indicated that as CI implementation progresses, teamwork and cross-functional teamwork increases. The teams they showcased became more effective, self-directed and established their own work standards to support continual improvement. Additionally, their team sessions led to more learning and member involvement, and teamwork fostered active and focused member participation.

In this sense, assuming individual inputs impact overall team performance, it is clear that the team unit influences the contributions of members as well. For Hwang *et al.* (2020), team formations advantages TQM and effective team environments influence employees positively and enhance the quality of work life. Furthermore, Hansen *et al.* (2020) connected smaller teams with high quality work, communication, trust and collective intelligence in a CI context. These attributes helped them handle emerging problems and reduced time and performance pressure. In accordance, Neirotti (2020) identified that a supportive team environment moderates the conflict between work intensification and employee involvement in CI settings.

In a similar manner, Harms (2015) conducted an experiment in a lean-startup-based entrepreneurship class, demonstrating that individual performance benefits from team learning, which subsequently enhances team performance. He proposed that group effectiveness depends on teams successfully fostering a culture of team learning within a psychologically safe environment. Confirming their expectations, their findings revealed that team learning is crucial for members' skill acquisition, and psychological safety encourages members to be creative, to experiment, and openly discuss content and team processes, thereby setting the tone for knowledge sharing.

In this regard, according to Maslow's theory of motivation (1943), psychological needs follow physiological and security needs, playing a crucial role in motivation, satisfaction, and overall well-being of workers in industrial settings. Employees who feel secure, have positive relationships at work, and receive recognition for their contributions are more likely to be engaged and motivated. Concordantly, Jaca *et al.* (2012) detected that team environments marked by teamwork and team recognition increased motivation and participation of members in CI initiatives of distribution centers.

Hence, acknowledging the pivotal role of teams in the success and sustainability of CI programs, and their capacity to foster talents' development - by amplifying their individual contributions and minimizing negative impacts of CI systems - leads to prioritizing team-focused improvement efforts to support CI initiatives more strategically.

1.3. A maturity lens in Continuous improvement contexts

1.3.1. Maturity positioning

The concept of maturity conveys a state of complete development (Cambridge Dictionary, n.d.) and is adopted across many fields. For lawmakers, maturity determines the legal responsibility of individuals according to their cognitive and psychosocial development Icenogle *et al.* (2019). In medicine and sports, biological maturity delineates the stage of development of physical, sexual and physiological characteristics Mirwald *et al.* (2002). Simply put, maturity must be contextualized to accurately express its meaning.

Similarly, for Miller (1983), no worker is globally mature or immature, but rather according to a certain task. Hersey and Blanchard (1993) conducted research on organizational change and stated that effective human management depends on understanding past behavior and predicting future behavior. In their situational leadership theory, managers must diagnose the specific situation they aim to influence, adapt to address its contingencies, and communicate successfully for acceptance, focusing on task-relevant maturity of individuals or groups.

In a socioanalytic study, Hogan and Roberts (2004) argued that maturity encompasses the relationship between individual and society, and that a cyclical positive effect exists between greater maturity and occupational performance. They explained that a mature person experiences increased adjustment and role-taking abilities, which reflects someone perceived by others as rewarding to deal with and likely to outperform and achieve career success.

In this sense, maturity impacts, and is impacted by, the environment and interactions with other people, and higher maturity leads to improved performance, which reinforces further maturity (Hogan & Roberts, 2004). Correspondingly, a group striving to become mature in certain aspects, triggers a process of cyclical growth that influences members and the environment, generating superior outcomes.

Furthermore, it is important to distinguish maturity from competence, as the latter represents a concern of organizations (Le Deist & Winterton, 2005) and is commonly employed in quality management in reference to hard and soft skills. Marrelli (1998) defined competence as measurable knowledge, skills, traits, and behaviors enabling effective task performance. For Pouydebat (2022), competence is not a state as it is expressed through action. On the other hand, a mature state is not limited to manifesting itself through concrete actions. Maturity can also act as a context or mind frame that subtly influences individuals. On this basis, maturity can have a direct or indirect impact on individuals, groups, and organizations. While competencies can be directly acquired or transferred (Pouydebat, 2022),

transferring maturity or directly enhancing it is not feasible; however, creating a supportive environment can facilitate or accelerate its development.

In essence, various qualities are associated with mature individuals, including consistency, adaptability, independence and responsibility, but isolated actions are insufficient to evaluate it (Vispo, 1966), and maturity produces distinct outcomes from both internal and external viewpoints (Vispo, 1966; Hogan & Roberts, 2004). **Altogether, maturity significantly shapes individuals, groups and their surroundings. Thus, its effects cannot be simplified or reduced. Additionally, it is important to recognize that maturity is inherently tied to human interactions, which highlights its shared and collective meaning.**

1.3.2. Maturity models

In the management landscape, the Capability Maturity Model (CMM) (Paulk *et al.*, 1993) introduced the notion of maturity models to assess and improve software development processes. For Becker *et al.* (2009), a maturity model is an artefact designed to determine the current state of a company's capabilities and provide improvement measures therefrom. It consists of a sequence of distinct maturity levels for a class of processes or for an organization, establishing their anticipated or desired evolutionary path, and providing the scale for the appraisal of their position along this path, based on a more or less comprehensive set of criteria (De Bruin & Freeze, 2005; Becker *et al.*, 2009).

Throughout an appraisal, a snap-shot of the organization is made and the relevant content is evaluated to identify the appropriate maturity level (Becker *et al.*, 2009). Simply put, a maturity model provides criteria and characteristics for each stage of a scale, and its application is typically supported by the use of questionnaires to determine a maturity level (Becker *et al.*, 2009). Moreover, according to the premises derived from the CMM, a process reaches its more mature level when it enters a phase of continuous improvement.

For Helgesson *et al.* (2012), maturity models package knowledge in a very useful way for improvement initiatives. They gained widespread popularity in different disciplines, thus motivating De Bruin and Freeze (2005) to formulate the main phases of generic model development and later, Becker *et al.* (2009) to propose a structured and well documented method to develop a maturity model for a determined subject.

Since then, considerable effort has been invested in developing maturity models, but the vast majority is missing evaluation to support their validity (Helgesson *et al.*, 2012; Tarhan *et al.*, 2016). In this sense, Helgesson *et al.* (2012) proposes to evaluate and improve maturity models through an internal verification of its understandability and consistency, followed by external expert analysis of the conformity between model and actual practice and, once these steps are concluded, throughout application in a real setting for process improvement. Still, Tarhan *et al.* (2016) found that the number of developed maturity models based on empirical work is very scarce and most models exhibit descriptive rather than prescriptive characteristics, failing to provide a pathway for improvement.

Kohlegger *et al.* (2009) analyzed the characteristics of existing maturity models' and found that only 10% focused on the maturation of individuals. Moreover, the authors state that these particular models are primarily focused on competence acquisition. For instance, the Dreyfus Model (Dreyfus & Dreyfus, 1980) describes how individuals advance from novices to experts through a five-level learning progression. Regarding teams, the People Capability Maturity Model (PCMM) (Curtis *et al.*, 2009) stands out for its evaluation of competence acquisition at the team level.

Within this context, the PCMM (a branch of the CMM) targets workforce capability improvement through processes focused on their management and development. Managers appropriate the model and apply its procedures to assemble and shape the workforce, building workgroups, fostering culture and developing individual capability. The model contains an extensive list of general practices to plan, integrate and measure the required knowledge, skills and abilities.

However, the PCMM considers a managerial perspective only and overlooks workforce dynamics. For instance, this framework includes empowering workgroups as a maturity step and the managerial practices to attain these are related to delegating activities and how the group should determine their own methods appropriately. **The framework does not provide insights about the group's perspective or internal measurements of its dynamics. In this sense, the performance related measurements in the framework are not sufficient to understand how members foster or hinder empowered workgroups, and how these groups form and evolve.**

1.3.3. Team maturity

For Katzenbach and Smith (1993), a team is a diverse group of individuals united by a shared purpose, performance goals, and working approach for which they hold themselves accountable. The authors argue that teams should be the fundamental unit of any organization, as they consistently outperform individuals operating within isolated activities and responsibilities. Teams are also more flexible than larger organizational units to address issues, but a group of people must meet specific attributes to become a team, which can still be categorized as high-performing or low-performing (Peters, 1997).

Hackman (1990) defines group performance through the effectiveness of a group to accomplish its tasks, their ability to sustain results over time and the professional growth of its members. In this sense, Katzenbach and Smith (1993) identified levels of group development associated with a team performance curve. Their theory posits that as a team matures, it moves from a state of reasonable performance to a reduced state of effectiveness due to disorder and uncertainty, before evolving into high performing states. Elrod and Tippett (1999) provided empirical evidence to this association and suggested that the core of the human change process is marked by transitions from normality through disruption and then to re-defined normality.

Furthermore, Peters (1997) linked team's development to the average level of members on Maslow's Hierarchy of Human Needs suggesting a direct correlation between team maturity level and the extent to which the members' human needs are fulfilled. His definition of team maturity concerned the elements:

- Respect and consideration for members;
- Accountability for responsibilities and performance standards;
- Effective individual and team communications;
- Coordinated development and alignment of individual and team goals;
- Recognition and reward of teamwork and team building efforts;
- Demonstration and encouragement of team loyalty.

Within this perspective, group development studies aim to understand how groups change over time and the characteristics and effects of their developmental stages (Levine & Moreland, 1990). Groups at advanced stages of development are more productive (Wheelan & Hochberger, 1996) and previous studies reinforced the correlation between advanced stages of group development and group effectiveness (Ramírez-Mora *et al.*, 2020; Murphy *et al.*, 2016; Leuteritz *et al.*, 2017); Levasseur, 2011), efficiency (Ramírez-Mora *et al.*, 2020) and performance (Gren *et al.*, 2017; Navarro *et al.*, 2016).

There are several group development models, each with distinct views regarding whether group evolution is linear or not, their suitability for different types of groups, and the specificity or comprehensiveness of their criteria (Smith, 2001). For instance, Tuckman (1965) and Wheelan and Hochberger (1996) developed a comprehensive, path dependent model adapted to various group types. Both models have 5 development stages and similar characteristics, but for Gren *et al.* (2020), the Wheelan and Hochberger (1996)'s one surpassed precedent work introducing more empirical research.

For Wekselberg *et al.* (1997), identifying the development stage of a group can only be useful if it also explicits which aspects contribute to it. Yet, given that maturity is contextual, the elements that contribute to its development can vary depending on the context a team is inserted and the specific role it is intended to fulfill.

Against this background, CI production teams are a unique type of group, distinguished by their application of specific tools and philosophy to generate and implement ideas for improving their processes (Van Dun & Wilderom, 2017). Progress in LM transformation triggers changes in communication patterns within teams and between teams and supervisors (Colazo, 2020), and shifts in work habits to contribute to an organizational culture of learning and knowledge sharing (Tortorella *et al.*, 2019). Particularly, it is reasonable to assert that these teams have different human dynamics than other effective groups (Van Dun & Wilderom, 2017).

Not all groups can be considered teams and it takes time to transform into a high-performance team (Katzenbach & Smith, 1993; Gren *et al.*, 2020). In this regard, CI production teams can progress more rapidly due to their characteristics, such as predefined roles and structured problem-solving (Easton & Rosenzweig, 2012).

However, the research of Guttenberg (2020) was the only one found associating a group development study with groups within a CI context. His research considered the definitions of Tuckman (1965) and revealed that groups adhering to its stages of progression completed more projects in total, on time, in less time and with greater cost reduction in comparison to others.

Altogether, evidence about how production teams form and develop in CI initiatives are insufficient (De Vries & Van der Poll, 2018), and no studies were found that proposed a group development model considering the maturity of teams operating within a CI environment.

1.4. Synthesis

Since its origins in TQM, CI has served as an engine to various quality management systems, with its management philosophy extending universally across all industrial sectors. Over decades, scholars and practitioners have put considerable effort in establishing guidelines, critical success factors, deployment levels and sustainability characteristics of CI programs. Yet, most of the CI initiatives are reported to fail.

The human element may hold the key to understanding why CI remains so challenging. Workers not only drive improvement but are also its primary subjects and those most affected by CI initiatives. In this regard, although human-related factors are often recognized as important, few studies have thoroughly investigated the workforce, typically focusing instead on technical aspects or managerial viewpoints.

Particularly, there is a lack of comprehensive workforce assessments that extend beyond knowledge factors and performance indicators to include soft practices and capture workers' perspectives. This limitation not only hinders improvement, but also restricts further theoretical and practical advancements in the CI field.

A closer investigation of the workforce in CI revealed that these settings demand a shift in mindset and behaviors, while requiring acceptance of, rather than resistance to, significant organizational change. In view of this, workers' behaviors and readiness towards change are significantly impacted by their team colleagues, who can either support or obstruct their progress towards continuous improvement.

In this sense, as performance is a collective outcome, teams should have an amplified impact on the success of CI initiatives, as they also play a key role in fostering individual talents, maximizing members' contributions, and mitigating potential negative effects of CI settings.

The team and its members influence each other's outcomes in a reciprocal and cyclical manner. From this perspective, the concept of maturity emerges as particularly relevant, since maturity shapes individuals and groups, ultimately determining their outcomes, and is not limited to actions, but accounts for this mutual influence between actors and their environments.

Maturity conveys a state of full development that inspired the creation of maturity models, widely used to assess processes. However, most maturity models are designed for managerial use only, and none were found that incorporate team dynamics or capture the direct perspectives of team members.

Furthermore, teams within a CI context have characteristics that distinguish them from other groups. Therefore, since evidence about these teams is lacking, and no group studies have focused on their particular development, it is pertinent to study the maturity of production teams in CI contexts.

Team maturity can be a holistic approach that indicates if a team can sustain CI initiatives and superior team maturity can be a state to strive for, in a setting that demands constant adaptation and evolution. A mature CI production team is highly adaptable and manages to establish an efficient work routine that advantages individuals' strengths and consistently improves processes and performance over time. Altogether, **team maturity offers a developmental aspect to teams, which can be accelerated by strategic interventions.**

In this light, **it is pertinent to develop a maturity model and an assessment approach** to measure the maturity of production teams within CI contexts. Thereby, this assessment can inform **the development of targeted improvement actions**, potentially integrating teams into a CI dynamic through a continuous feedback loop of maturity assessment and improvement.

It is important to interrogate all members to assess team maturity, and the approach can engage each one individually. In this sense, the team maturity model and assessment approach can unfold a **maturity level through members' self-evaluation of team maturity,** capturing their direct perspectives and encouraging an improvement mindset. Moreover, an assessment through members' evaluations is also appropriate due to maturity's multifaceted nature and qualitative essence, rather than purely technical.

A team maturity approach benefits both companies and their workforce. For example, mature teams create macro-level advantages, such as a positive team environment that enhances members' satisfaction and well-being within the organization, thereby reducing turnover rates in companies.

To address a main challenge faced by organizations in a pursuit of CI, this thesis proposes to contribute to the following research question: "**How can organizations engage the workforce in a CI dynamic to support initiatives?**"

Toward this goal, **the proposed team maturity approach** is structured around 3 core phases: identifying team maturity, assessing it, and driving its improvement. In other words, to effectively study team maturity, it is essential to first identify the defining characteristics of mature production teams within CI contexts. Thereafter, team maturity can be assessed accordingly through a defined strategy and enhanced through a tailored improvement plan.

The objective is to propose a practical approach designed to engage the workforce in the CI dynamic, supporting the success and sustainability of initiatives through team maturity assessment and improvement. To address this goal, this thesis aims to provide answers to the following sub-questions:

- What are the characteristics of mature CI production teams?
- How to assess the maturity of CI production teams?
- How can organizations be further supported in developing tailored team maturity improvement plans?

Chapter 2

A maturity characterization of CI production teams

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Although the importance of teams in driving CI is widely acknowledged, this recognition often fails to translate into meaningful outcomes in practice; the existing CI literature that primarily addresses production teams is limited. From this viewpoint, our objective is to identify the maturity of production teams in CI contexts, aiming to uncover the team dynamics that enable sustained collective efforts necessary to support CI initiatives over time.

Our approach starts with investigating teams in the field of group research. Examining teams within other well-established research contexts can uncover insights and dynamics that have not yet been explored in the existing CI literature. Subsequently, the focus narrows to the CI field. This strategy ensures that all relevant aspects are considered before concentrating on the specific characteristics of teams within a CI context, aiming to develop a framework that is both comprehensive and precisely adapted.

This chapter is organized as follows: sections 2.1 and 2.2 provide an overview of group studies, highlighting key areas of research, including the prominent domain of group development. Section 2.3 examines group maturity and group development, while Section 2.4 focuses on the maturity of production teams within CI settings. Section 2.5 synthesizes these findings to propose a characterization of team maturity, and section 2.6 outlines the elements that constitute this characterization. Finally, section 2.7 examines this proposed characterization within a broader context.

2.1. Group studies

Research on groups is broad and multidisciplinary by nature. Levine and Moreland (1990) performed a comprehensive review of the literature featuring small groups and identified 5 basic aspects of groups investigated by scholars:

- **Composition:** members are the most important resource of a group. Researchers explore aspects such as group size, demographic traits, abilities, opinions, and personalities of members. These investigations employ various measures, including central tendency, variability, and specific configurations of members.
- **Structure:** the structure of a group refers to the pattern of relationships that emerges among its members. Studies focus on status systems, norms, roles, or cohesion and they often involve a conceptualization of group structure, psychological processes that produce it and its effects on the groups and its members.
- **Internal conflicts:** conflict emerges when group members believe that their objectives cannot be achieved simultaneously. Researchers assert that conflict can involve issues such as the distribution of resources, access to information, and decision-making power. Coalition formation, and the influence of the majority and the minority are also significant topics.
- **Performance:** group performance encompasses both the process and outcome of members' collaborative efforts to achieve a collective goal. Research on the subject can be divided into three general topics: leadership, productivity, and decision-making.

- **Ecology:** a group exists within a setting and is influenced by it; thus, fully understanding a group requires analyzing its setting as well. These analyses revealed environmental factors, including physical, social and temporal elements.

In organizational settings, composition of teams can change, but industrial managers often have no control over personalities or members they are assigned. Cini (2001) affirms that groups hardly remain as static entities; the passage of time affects groups in various ways (Levine & Moreland, 1990; Cini, 2001). In this sense, regarding the ecology of groups, research on temporal aspects is more prevalent, with group development being the most commonly studied area. Additionally, group development studies also address aspects such as group structure, internal conflicts and performance (Wheelan & Hochberger, 1996).

Sarri and Galinsky (1974) described group development as the changes over time in the internal structures, processes and culture of groups. In fact, group development theory posits that every group operates at some developmental level, which in turn affects other group aspects (Levine & Moreland, 1990) such as performance and internal conflicts (Wheelan & Hochberger, 1996).

For Buzaglo and Wheelan (1999), the productive workgroup has navigated the earlier stages of group development and evolved to be a mature, high performing unit capable of achieving its goals and tasks. Thus, strategies to improve effectiveness should concentrate on assisting teams to attain higher stages of development. Likewise, management approaches to enhance performance are contingent upon the distinct characteristics and circumstances of work groups, so they are more likely to succeed if tailored to their developmental stages (Buzaglo & Wheelan, 1999).

Moreover, on the ecology of groups, a group can perceive its environments in ways that make it appear more or less pleasant, and researchers that examined groups in factories or offices affirm that working conditions affect job satisfaction, which in turn affects worker productivity (Levine & Moreland, 1990). Considering this perspective and the positive correlation between group development and workers' performance (Wheelan & Hochberger, 1996), enhancing work conditions can effectively promote group development as well. **Finally, the adoption of a group development model helps to identify group factors and improvement opportunities through the analysis of group activities** (Maynard & Jacobson, 2019)**.**

2.2. Group development models

For Wheelan and Hochberger (1996), groups at advanced stages of development are more productive, but the challenge remains at apprehending how they operate and their evolutionary processes. In this sense, (Smith, 2001) examined group development models, outlining their similarities and differences and their evolution through the years. He organized the extensive body of literature and identified 3 classifications for these models:

- **Linear progressive models:** groups develop in a linear sequence, progressing through a defined order of stages or phases. These models are considered sequential in time and a fitting

analogy is a flight of stairs: a group must climb each successive step to reach the top and achieve full development.

- **Cyclical:** groups revisit stages and phases of development repeatedly or oscillate between recurring issues during the developmental process. The stages of development in these models have no specific order as groups cycle and swing back and forth between them.
- **Non-sequential:** group development is contingent on the environmental factors that impact the development process. These models do not present a prescribed pattern of development.

For Ito and Brotheridge (2008), linear models excel at describing well-defined stages and characteristics of development, whereas cyclical or pendular models contribute by acknowledging that group dynamics can shift in response to events. Chang *et al.* (2003) investigated project teams and demonstrated that both types of model are valid, revealing a complementary relationship between them rather than an exclusive one. They affirmed that group development models are different lenses for examining behavior and all groups progress through the stages of both models. Moreover, the authors asserted that when implementing significant changes within a work group, a change agent can draw on insights from both models to effectively prepare for the transition. Likewise, researchers can opt for either model (Chang *et al.*, 2003).

Furthermore, Bessant and Caffyn (1997) identified cumulative behaviors of individuals and groups corresponding to the developmental stages of a CI initiative, which Jørgensen *et al.* (2006) later suggested may not follow the linear progression originally proposed.

However, it is pertinent to resort to aforementioned linear models to capture the characteristics of developed groups (Ito & Brotheridge, 2008). **In this sense, instead of assuming different behavior patterns for each developmental stage, we consider it more effective to identify the elements that define developed groups and assess them individually to design targeted improvement interventions.**

2.3. Group maturity and group development

2.3.1. Systematic Literature Review

A SLR was conducted with the overarching goal of grasping group maturity and group development within relevant settings: organizational, project and change contexts. The protocol applied for the SLR followed the guidelines of Lacerda *et al.* (2014) and is summarized in Figure 2.1.

First, Web of Science was the database of choice, since it is renowned for its thorough coverage of international journals in engineering and industrial management (Sanchez & Blanco, 2014). Subsequently, to achieve a current and comprehensive understanding of the subject, broad keywords were deliberately chosen: “collective maturity”, “group maturity” and “group development” (Figure 2.1). A temporal filter was applied to comprise documents from the last 10 years, extending from 2011

to October 2021. In addition, a filter was also applied to limit the results to articles published in academic journals only.

The initial sample comprised 446 articles. First, duplicates were discarded. Thereafter, all titles were screened, and those considered unrelated to the investigated subject were removed. Next, the abstracts were reviewed, and those lacking alignment to the research purpose were also excluded. At last, the 29 remaining articles were read, and 15 were discarded, resulting in a final selection of 14 articles to compose the core dataset for this group maturity and development.

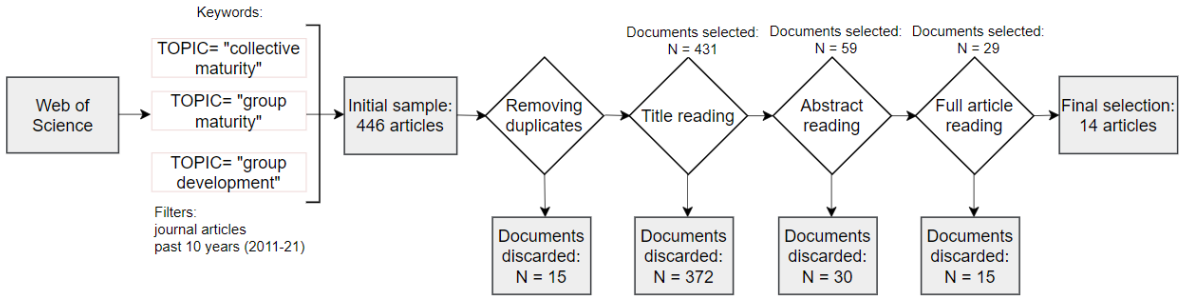

Figure 2.1 : Article selection for the SLR on group maturity and group development

The selected articles (Table 2.1) allowed a comprehensive view on group maturity and group development, and included studies from journals in various disciplines such as psychology, education and computer science. The main findings are outlined in the following paragraphs.

Most studies examined actual groups in relation to the group development linear progressive models of Tuckman (1965) and Wheelan (1994), also referred to as stage models. An exception is Garfield and Dennis (2012), who studied project groups in a hospital to determine which development model they followed. They found that groups of nurses enacting routines they already know can quickly begin work, with development following a cyclical model. In contrast, groups whose usual routine is disrupted (for example, by a new technology), have to develop new work processes before work can begin, and group development follows the stage model.

Largent (2016) provided evidence to the applicability of stage models to students' groups in computer science disciplines. He indicated that the stages in Tuckman (1965) can serve as an effective tool to teach and monitor group development in computer science courses and suggested that they apply to most types of small groups. Likewise, Gwandure and Boshoff (2019) assessed and confirmed the alignment between Wheelan's (1994) theory and organizational practices in South Africa. They conducted a survey with participants that had completed postgraduate courses on group processes and dynamics and the participants were able to clearly identify the discrete stages of group development within their various work experiences.

Table 2.1 : Selected articles on group maturity and group development.

Journal	Authors and year	Title
Australasian Journal of Educational Technology	Cheng and Yang (2011)	*Student team projects in information systems development: Measuring collective creative efficacy*
Interfaces	Levasseur (2011)	*People Skills: Optimizing Team Development and Performance*
Journal of Management Information Systems	Garfield and Dennis (2012)	*Toward an Integrated Model of Group Development: Disruption of Routines by Technology-Induced Change*
Papeles del Psicólogo	Meneses and Navarro (2015)	*How to improve team effectiveness through group processes: an example in the automotive industry*
ACM Transactions on Computing Education	Largent (2016)	*Measuring and Understanding Team Development by Capturing Self-assessed Enthusiasm and Skill Levels*
Social Work in Public Health	Murphy, Franz and Callaghan (2016)	*Group Maturity in a Community-Based Project*
Journal of Systems and Software	Gren, Torkar and Feldt (2017)	*Group development and group maturity when building agile teams: A qualitative and quantitative investigation at eight large companies*
Journal of Software: Evolution and Process	Al-Sabbagh and Gren (2018)	*The connections between group maturity, software development velocity, and planning effectiveness*
Journal of Environmental Planning and Management	Maynard and Jacobson (2019)	*The influence of group maturity on community-based environmental management in Kenya*
International Journal of Training Research	Gwandure and Boshoff (2019)	*Alignment between theory and practice in group development processes in the workplace: an experiential perspective*
Journal of Interprofessional Care	Klarare, Hansson, Furst and Hagelin (2019)	*Team type, team maturity and team effectiveness in specialist palliative home care: an exploratory questionnaire study*
Journal of Software: Evolution and Process	Gren, Goldman and Jacobsson (2020)	*Agile ways of working: A team maturity perspective*
Journal of Software: Evolution and Process	Ramírez-Mora, Oktaba and Pérez (2020)	*Group maturity, team efficiency, and team effectiveness in software development: A case study in a CMMI-DEV Level 5 organization*
International Journal of Lean Six Sigma	Guttenberg (2020)	*Group development model and Lean Six Sigma project team outcomes*

Nevertheless, specific group contexts such as community-based projects can escape stage models' developmental track, as indicated by Murphy *et al.* (2016). The authors examined a health committee in Spain where group maturity is a process of negotiation rather than consensus, and thus groups do not follow a model of group development.

In the agile context, Gren *et al.* (2017) investigated the connections between software engineering teams and group development stage models and found that all agility factors were significantly correlated to group maturity, and group development provides guidance to agile project management. The authors suggested that there appears to be a universal pattern in the behavior of all types of groups, regardless of sector or geographical location. They argued that teams aiming to become more agile may benefit from incorporating a group psychology perspective, which helps them understand their needs beyond the specific agile processes they seek to implement.

Moreover, Al-Sabbagh and Gren (2018) provided evidence that software development groups with higher scores in a group development stage model attain the desired quality of their products. Hence, the implementation of agile projects must be adapted to the maturity levels of agile teams, as there is a strong correlation between group development stages and agile practices in software development organizations (Gren *et al.*, 2020). In this sense, Levasseur (2011) affirmed that the stages of group development combined with change management principles and practices are useful to provide ideas for developing high performing teams.

Ramírez-Mora *et al.* (2020) investigated the relationship between group maturity, efficiency and effectiveness of agile teams in software development organizations. Aspects of group maturity were correlated with effectiveness and efficiency measures and the authors listed representative characteristics of group maturity based on the descriptions of the group development stage models of Tuckman (1965) and Schermerhorn (2002):

- Effective communication;
- Backup behavior;
- Clarity of roles and goals;
- Conflict management;
- Shared decision-making;
- Cohesiveness;
- Mutual trust;
- Conformity.

Furthermore, Ramírez-Mora *et al.* (2020) reported that managers and group leaders find that group behavior is crucial for project success and that managing group dynamics is more challenging than addressing technological issues. In addition, communication was described as an enabler to other development characteristics.

Guttenberg (2020) investigated Lean Six Sigma project teams in the service sector and found that teams advancing through a group development stage model completed more projects, met deadlines more consistently, diminished project completion times and reduced costs. He pointed out that leaders who understand team dynamics and group development stage models are better equipped to build high-performing teams. He gathered information from middle-level employees only and his study focused on the importance of teams following the specific developmental pattern of Tuckman (1965).

The sole study identified in the SLR regarding the assessment of production groups, Meneses and Navarro (2015) examined 72 groups in the automotive sector in Spain and showed that group development, identification of members and group potency are significantly correlated to each other and also predict group performance, absenteeism, quality, improvement ideas and order and hygiene in the workplace. Group potency refers to the belief of the group about its ability to achieve its goals, while identification of members is associated with their sense of belonging. The authors indicated that assessing group processes and implementing targeted training programs can enhance the effectiveness and performance of existing teams, emphasizing that evaluation tools for these group dynamics are crucial for effective team management and can help reduce the training needs for managers responsible for diagnosing team issues.

Concerning the influence of time on teams, Klarare *et al.* (2019) studied palliative care teams in Sweden and found that length of time alone is not an indication of group maturity. Maynard and Jacobson (2019) also compared older and younger teams in community-based programs in Kenya, providing evidence that group age is not the most important predictor of group maturity. However, in group development theory, it typically takes a group around 6 months to become high-performing Wheelan (2009) and Al-Sabbagh and Gren (2018) emphasized that agile work groups need sufficient time to develop in order to reach higher levels of effectiveness.

Pertaining to individuals participating in teams, (Klarare *et al.*, 2019) suggested that individuals bring competencies to the group and these are refined within the team, so individuals lacking competence or maturity affect how the team works. Likewise, Cheng and Yang (2011) indicated that motivation and knowledge of members are drivers of collective creativity within project teams. Still, Ramírez-Mora *et al.* (2020) found no relationship between the age of members and the maturity level of the group.

In addition, according to Ramírez-Mora *et al.* (2020), organizational maturity can drive group development, as software teams need to achieve efficiency and effectiveness goals through well-established processes. Still, team members must have a clear understanding of their roles and tasks to achieve project goals. In a similar manner, Gren *et al.* (2020) suggested that contextual factors can impact team maturity. They observed that external factors within the company ecosystem, beyond the team's control, could lead to low team maturity.

Overall, group development models are useful to identify relevant group maturity characteristics and prioritize their improvement (Maynard & Jacobson, 2019). **Therefore, it is pertinent to use a group development model for team management within organizational settings, and the SLR confirmed that the stage model of** Susan Wheelan (1994) **is particularly appropriate for this purpose, since it also synthesizes and builds upon earlier research, including** Tuckman's (1965)**.**

2.3.2. The Integrative Model of Group Development

Susan Wheelan's Integrative Model of Group Development (IMGD) (1994) is a comprehensive, linear progressive model, adapted to all types of groups (Smith, 2001). It is also described as a life cycle model that incorporates ideas from other various approaches of group development, including sequential, cyclic, equilibrium and non-sequential models (Gren *et al.*, 2017; Gwandure & Boshoff, 2019).

Wheelan (1994) studied groups in various contexts, such as for-profit and nonprofit organizations, government related, health-care facilities, therapy and laboratory settings, among others, to conceive her group development model. In the IMGD, the 5 stages of group development are:

- **Stage 1: Dependency and inclusion.** In this stage, members significantly depend on the designated leader. Tension and anxiety are frequent among members and they do not rely on each other for support or structure. Group members initiate attempts to determine rules, roles, and structure. Members often display politeness, tentativeness, and defensiveness, and they evade work by engaging in off-topic discussions or withdrawing from tasks. Work occurs at minimal levels.
- **Stage 2: Counterdependency and fight.** This stage is defined by conflict among members and between members and leaders, and it also includes task avoidance. The group struggles about how it will operate and coalitions are formed in attempts to define group structure and roles. Conflict is necessary to this process to achieve a unified direction for the group and create a safe environment thereafter, also paving the way to mature collaboration.
- **Stage 3: Trust and structure.** At this stage, the group is designing itself. After conflicts were successfully navigated, the group begins a more mature negotiation about goals, structure, procedures, roles and division of labor. Communication becomes more open and task oriented, and information is shared rather than used for gaining status or power. The group's capacity to work effectively and productively increases.
- **Stage 4: Work.** In this stage, goals, structure and norms are determined, enabling the group to function effectively. Members communicate openly about ideas and information. Groups work effectively, with a conscious awareness of time management, including a portion dedicated to group maintenance.
- **Stage 5: Termination.** The end point for temporary groups. The dissolution of a group implies a regression to earlier stages of group development.

Furthermore, the IMGD advances previous work by introducing empirical research to a field that was previously almost entirely observational (Wheelan & Hochberger, 1996). Wheelan's work integrates extensive empirical research and is the single evidence-based group development model known to date (Gren *et al.*, 2017; Al-Sabbagh & Gren, 2018).

In fact, one of Susan Wheelan's significant contributions to group research was the development of a statistically validated instrument, the Group Development Questionnaire (GDQ), which was designed to measure the developmental stage of a given group at a given time (Gren *et al.*, 2017; Al-Sabbagh & Gren, 2018).

According to Wheelan and Hochberger (1996), this instrument appears to be valid across diverse fields. However, it is not available in their report and the authors have established a GDQ training program, as they claim that adequate training is necessary to ensure its proper use. In this regard, GDQ certifications are currently offered through on-site and online courses, allowing individuals to become certified consultants and apply the tool.

Wheelan and Hochberger (1996) provided some information about the content of the GDQ: it consists of 4 parts, each corresponding to one of the 4 stages of group development and comprising 15 items. Respondents must evaluate whether their group situation aligns with each one of the 60 items. There is not a measure for the fifth stage, Termination, as the authors designed the instrument for use with ongoing groups only. The authors provided a small sample of the items contained in the GDQ, which is partially reproduced in Table 2.2.

Table 2.2 : Sample items of the GDQ from Wheelan and Hochberger (1996).

GDQ	**Sample items**
Stage 4: Work.	▪ The group gets, gives, and uses feedback about its effectiveness and productivity. ▪ The group acts on its decisions. ▪ This group encourages high performance and quality work. ▪ …

Wheelan and Hochberger (1996) developed the GDQ items based on an extensive list of group characteristics they observed and compiled for the first four stages of group development. They presented these evolving characteristics for each stage, with Table 2.3 offering a sample to illustrate its content.

Altogether, the IMGD framework offers a description of the developmental patterns of groups. Still, Wheelan and Hochberger (1996) also established the evolving characteristics groups exhibit at each stage of development (Table 2.3). **These insights can thus be leveraged to identify fundamental elements that indicate maturity within all types of groups.**

Table 2.3 : Some characteristics of group development adapted from Wheelan and Hochberger (1996).

Development stage	**Characteristics**
1: Dependency and inclusion	▪ Members are concerned with acceptance and inclusion; ▪ Members fear group rejection; ▪ Goals are not clear to members, but clarification is not sought; ▪ The group assumes that consensus about goals exist; ▪ A lack of group structure and organization is evident; ▪ Communication tends to be centralized; ▪ Conformity is rare; ▪ Member deviation from emerging norms is rare; ▪ …
2: Counterdependency and fight.	▪ Conflict about values emerge; ▪ Clarification of goals and roles begin; ▪ Increased feelings of safety allow dissent to occur; ▪ Members challenge the leaders; ▪ Subgroups and coalitions form; ▪ Decreased conformity begins; ▪ Conflict resolution, if successful, increases trust and cohesion; ▪ …
3: Trust and structure.	▪ Increased goal clarity and consensus are evident; ▪ Roles and tasks are adjusted to increase goal achievement; ▪ Communication becomes more flexible; ▪ Cooperation is more evident; ▪ Pressures to conform increase again; ▪ Member satisfaction increases; ▪ The group works to clarify and build an effective group structure; ▪ …
4: Work.	▪ Members are clear and agree about goals; ▪ Tasks are appropriate to group versus individual solution; ▪ Role assignments match member abilities; ▪ The group has an open communication structure in which all members participate and are heard; ▪ Voluntary conformity is high; ▪ The group norms encourage high performance and quality; ▪ The groups implement and evaluates its solutions and decisions; ▪ The group has access to technical and human relations training when needed; ▪ …

2.3.3. Maturity dimensions identification

Based on Wheelan's (1994) group development model and its associated characteristics (Table 2.3), we identified 4 distinct dimensions of group development, as they summarize the evolving processes of groups across stages: **Group Behavior, Communication, Members' relationship and Work Level.**

The structure we propose below is based on the IMGD descriptions and delineates these 4 dimensions, as well as a corresponding group characteristic of each dimension through the 5 development stages (Figure 2.2). Still, the arrangement also highlights that time is a crucial factor for progression, and development unfolds in a closely interconnected manner, as each dimension is interdependently related.

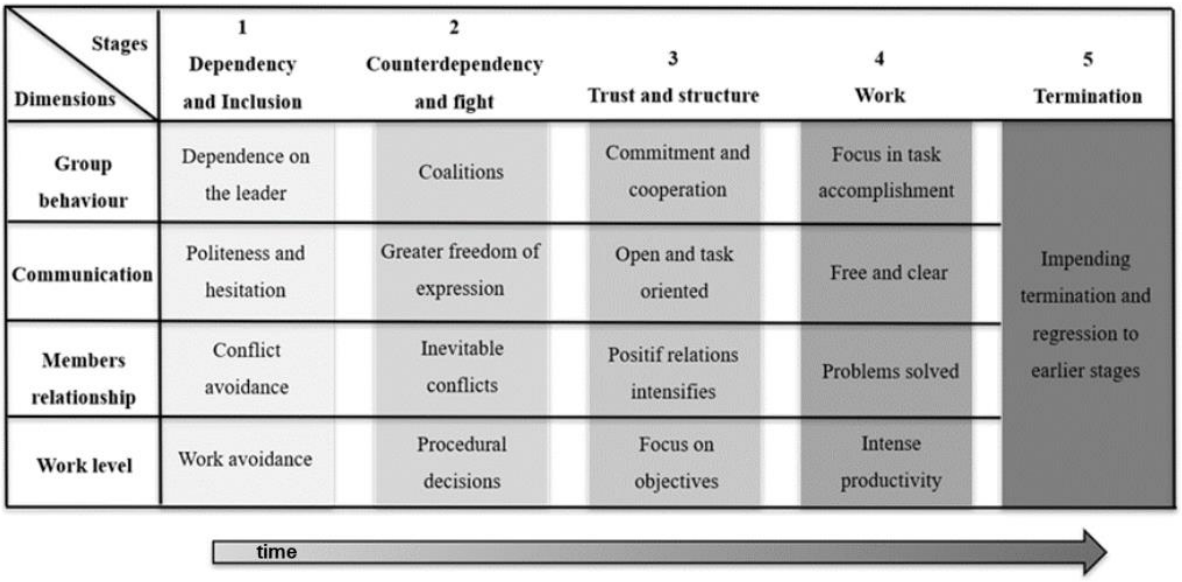

Figure 2.2 : Proposed dimensions of group development and related stage characteristics, extended from Wheelan (1994).

The 4 identified dimensions represent the core categories regarding the evolving aspects or processes of groups, shifting focus away from the numerous group characteristics and their progression throughout the development stages (see group characteristics' sample in Table 2.3). Moreover, the proposed structure (Figure 2.2) allows for a more precise and targeted analysis of how group development unfolds according to the IMGD, and it aims to provide a clear view of the maturity dynamics within groups, so to facilitate further research aimed at investigating groups within CI contexts.

2.4. Continuous improvement and production teams

As previously discussed, our research focuses on examining the maturity of production teams within the CI context. It is coherent to affirm that CI teams have different human dynamics than other effective groups (Van Dun & Wilderom, 2017), therefore it is important to identify the specific elements that constitute their maturity.

In this sense, Easton and Rosenzweig (2012) examined successful and failed Six Sigma improvement projects over a 6-year time span providing empirical evidence that:

- There is no relationship between individual experience and project success;
- There is a weak relationship between team familiarity and project success.
- There is a significant relationship between organizational experience and project success;
- There is a strong relationship between team leaders experience and project success;

In essence, CI projects are primarily driven by production teams, which makes these teams the critical unit for achieving CI success. In organizations with a well-developed and deployed structured problem-solving process, the role of experienced leaders is crucial and can guide production teams towards successful outcomes, whether team members have previously collaborated or not (Easton & Rosenzweig, 2012).

Certainly, leadership is a confirmed critical factor for CI success (McLean *et al.*, 2017; (Gastelum-Acosta *et al.*, 2022; Lopes *et al.*, 2023). Nevertheless, according to Nogueira *et al.* (2018), there is not a specific leadership style that benefits Lean Management. For Poksinska *et al.* (2013), as LM advances, leadership requirements shift over time. The authors argue that in the early stages of self-managing CI production teams, there is a greater need for active leadership, which decreases as the team matures.

In fact, CI methodologies rely on proactive teams and a participative work design enhances proactivity through team learning processes (Lantz *et al.*, 2015). Mathew and Taylor (2019) reported the damaging effects of a culture oriented towards hierarchy in a LM transplantation, noting its incompatibility with the decentralization endorsed by LM through its foundations: employee empowerment, delegation, responsibility and team-based work groups.

Overall, organizational characteristics resonate on the success of any management practice (Tortorella *et al.*, 2015) and contextual differences create a significant impact on LM implementation (Macias De Anda *et al.*, 2022). Colazo (2020) highlights that most research focuses on how management drives the success of LM, but fails to include data from workers themselves. He argues that directly incorporating the perspective of production teams is crucial for accurately explaining successful implementations. **From this standpoint, identifying the precise elements that define maturity for production teams in CI contexts is also crucial for evaluating and selecting the most suitable leadership style and management actions that can accelerate production teams' maturity.**

2.4.1. Systematic Literature Review

A SLR was conducted to investigate production teams functioning within CI contexts and to identify their maturity characteristics. The applied SLR protocol also followed the guidelines of Lacerda *et al.*, (2014) and is summarized in Figure 2.3.

In the Web of Science database, the selected keywords aimed to provide a comprehensive view of CI teams: "lean teams" and "continuous improvement teams" (Figure 2.3). Thereafter, articles published

in academic journals from 2011 up to February 2022 were searched. The initial sample had 1704 articles. Duplicates were removed, and all titles were screened, followed by a screening of the remaining abstracts. Those studies deemed irrelevant to the research objectives were discarded. At last, 71 articles were read and 28 discarded. This process resulted in a final selection of 43 articles, which offered valuable insights into CI production teams, including 11 articles that served to identify their maturity elements.

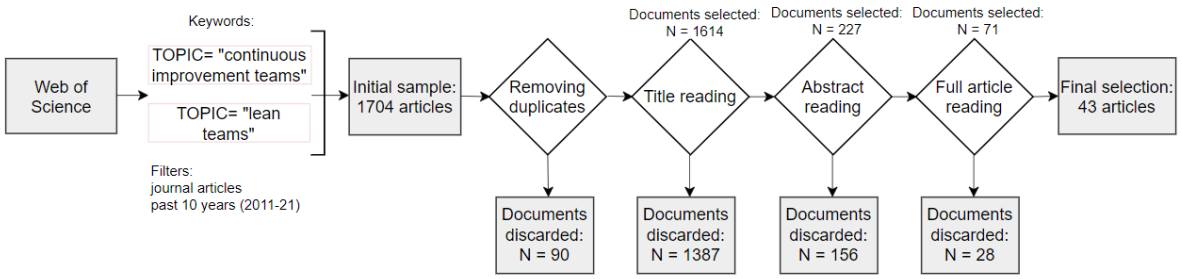

Figure 2.3 : Article selection for the SLR on production teams in CI contexts.

The selected articles offered a thorough view on teams within CI contexts and CI initiatives. Furthermore, 11 articles were highlighted, as they provided empirical research featuring the evaluation or assessment of CI production teams. The majority of these 11 studies were carried out in manufacturing settings, with a few also covering the service sector. They were accomplished mainly in Europe, but also include Africa, Asia, North and South America. Their methods, research samples and main findings are outlined in Table 2.4.

This set of empirical studies revealed the effects of CI environments on teams, and aspects within the production teams that indicated whether they were successful or not. It provided an insight into the dynamics of production teams within CI contexts. **The discovered aspects are essential features or characteristics that teams must develop or improve to sustain CI initiatives, thus they can be leveraged to identify the specific maturity elements of CI production teams.**

Table 2.4: Selected articles on production teams within CI contexts.

Journal	Authors and year	Methods	Sample Size	Key findings
Total Quality Management & Business Excellence	Jaca *et al.* (2012)	Action Research	3 production teams for CI projects and management teams of a service company in Spain	The paper introduced a change management methodology for adopting lean practices in distribution centers, emphasizing key aspects of organizational change, including employee training, teamwork, and team recognition.
Employee Relations	Rolfsen and Langeland (2012)	Interviews and observation	1 production team of an automotive company in Norway	Managers, team leaders, and production workers identified a high level of autonomy (denoted through participation and empowerment) as crucial for LM success. In addition, increasing team responsibility enhances commitment and fosters team spirit.
Journal of Workplace Learning	Lantz *et al.* (2015)	Surveys	56 production teams of an automotive company in Sweden	The results indicated that involving teams in decisions related to work design and inter-team collaboration fosters team communication and a shared understanding of team goals and strategies. This, in turn, stimulates proactive behavior within the team.
International Journal of Technology Management	Grant and Hallam (2016)	Longitudinal surveys	5 production teams of a manufacturing company in the United States	The study highlighted that involving production teams in setting priorities, promoting and rewarding collaboration among team members, and fostering team flexibility are critical initiatives for helping teams adapt to lean system implementation.
Proceedings: 22nd International Conf. on Industrial Engineering and Engineering Management	Wang *et al.* (2016)	Observation	385 production teams of an automotive company in China	The development of an evaluation system serves as a reference for team management in manufacturing organizations. Key elements of this system include safety, talent development, team recognition, quality, and efficiency.

Journal	Authors and year	Methods	Sample Size	Key findings
Journal of Mechanical Engineering	Berlec *et al.* (2017)	Surveys	production teams and core project teams in 2 automotive companies	The authors propose and test a model to facilitate successful lean implementation, which consists of five steps combined with lean learning for management and employees. The basis of the model are managerial support, communication and knowledge about lean principles and philosophy
Production & Manufacturing Research	De Vries and Van der Poll (2018)	Interviews	2 production teams of 2 manufacturing organizations in South Africa	The article explored team formation and evolution during LM transformations and found that successful organizations begin with a well-defined LM strategy that prioritizes employee involvement and team development.
Project Management Journal	Hansen *et al.* (2020)	Longitudinal interviews and observation	1 field team in a shipbuilding company	Identification of structured processes through which the CI project team handled emergent issues and built collective intelligence: trust reinforcement, information sharing, division in smaller teams, control of time and performance pressure, goal awareness and direct communication among team members.
International Journal of Quality & Reliability Management	Colazo (2020)	Surveys	10 production teams of a manufacturing company in South America	The results revealed that as LM progresses within the organization, communication among team members and between teams increases.
International Journal of Operations & Production Management	Van Dun and Wilderom (2021)	Longitudinal surveys, interviews and observation	5 production teams in manufacturing and service companies in the Netherlands	The paper indicated that successful CI initiatives over time have: regular performance monitoring, information sharing, and peer support among team members, team leaders who balance task-oriented and relations-oriented behaviors, and high-level leaders who provide face-to-face support, strategic clarity and abundance of resources to the team.
Total Quality Management & Business Excellence	Tortorella *et al.* (2021)	Focus groups	2 production teams in an automotive company	The results indicated that emphasizing performance improvements, fostering a sense of ownership and belonging, and interpersonal relationships among team members positively influence team behavior to sustain CI initiatives.

2.4.2. Maturity elements identification

Building on the insights gained from the SLR, we identified maturity aspects from 11 empirical studies (Table 2.4), and the resembling ones were merged to establish **14 maturity elements of production teams to support CI programs** (Table 2.5). Our objective was to comprehensively identify the maturity of production teams in CI contexts and portray it through well-defined maturity elements.

Table 2.5 : Maturity elements of production teams within CI contexts.

Maturity elements/references	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Communication openness					✓	✓		✓	✓	✓	✓
Collaboration	✓			✓	✓		✓			✓	✓
Autonomy level		✓	✓				✓				✓
Performance level				✓	✓					✓	✓
Shared goals			✓	✓	✓						✓
Collaboration with other teams and departments			✓				✓				✓
Participatory problem solving			✓		✓						✓
Shared meaning			✓		✓						✓
Communication openness with the program manager									✓		
Communication with other teams and departments									✓		
Performance monitoring between members										✓	
Roles organization in the team											✓
Shared values										✓	
Trust								✓			

1- Jaca *et al.* (2012); 2- Rolfsen and Langeland (2012); 3- Lantz *et al.* (2015); 4- Grant and Hallam (2016); 5- Wang *et al.* (2016); 6- Berlec *et al.* (2017); 7- De Vries and Van der Poll (2018); 8- Hansen *et al.* (2020); 9- Colazo (2020); 10- Van Dun and Wilderom (2021); 11- Tortorella *et al.* (2021).

The 14 proposed maturity elements capture the essential dynamics of teams required to effectively support CI implementation. Section 2.5 provides a detailed definition of each element, outlining their specific contributions to overall team maturity. Before that - in order to establish their relevance in actual CI settings - these elements must be validated by CI field experts to confirm their critical role in sustaining successful CI programs.

2.4.3. Expert interviews

Semi-structured interviews were conducted with 2 experts in CI management with vast experience in coordinating production teams, to collect their opinions on the maturity of production teams. The aim was to confront literature findings against their experiences and to gather an external appraisal on research pertinence. The experts have more than 8 years of experience leading CI transformations in different companies.

Both interviews were recorded and key points were transcribed. Interviews lasted an average of 75 minutes, during which open-ended questions were employed to elicit their perspectives on team maturity and aspects they recognized in production teams that successfully maintained CI initiatives over time. During the later stages of the interviews, experts were encouraged to share their views on the maturity elements identified through the literature reviews, especially those they had not yet addressed in their discourse.

Furthermore, the experts' interviews revealed that the number of published works referencing a maturity element does not necessarily reflect its importance in a practical CI context. For instance, the experts emphasized Trust as a highly important feature, despite it being mentioned only once in the CI literature.

Altogether, the maturity elements identified in the literature were corroborated by the experts' opinions. Moreover, the CI practitioners endorsed the idea of maturity progression over time, highlighting time as a crucial condition for team development.

2.5. Team maturity characterization

A team maturity characterization is proposed by consolidating the findings from the preceding research phases (sections 2.3 Group maturity and group development and 2.4 Continuous improvement and production teams). To provide a clearer view of this process, Figure 2.4 illustrates the methodological steps employed in developing the team maturity characterization.

At first, a general investigation about group studies and a SLR on group maturity and group development resulted in the adoption of a group development model, the IMGD. This initial step resulted in the apprehension of the evolving characteristics of groups through different development stages. Likewise, the output was the proposal of 4 structured dimensions synthesizing the main evolving aspects of groups across stages (section 2.3.3 Maturity dimensions identification).

Subsequently, a SLR was performed on the subject of CI production teams to examine the specific maturity characteristics of these groups. Thus, maturity aspects were identified from 11 empirical studies and merged to form 14 maturity elements of CI production teams (Table 2.5, section 2.4.2 Maturity elements identification). At last, interviews with practitioners with experience in CI management and production teams' coordination were conducted, and an analysis of their discourses confirmed maturity elements and research pertinence (section 2.4.3 Expert interviews).

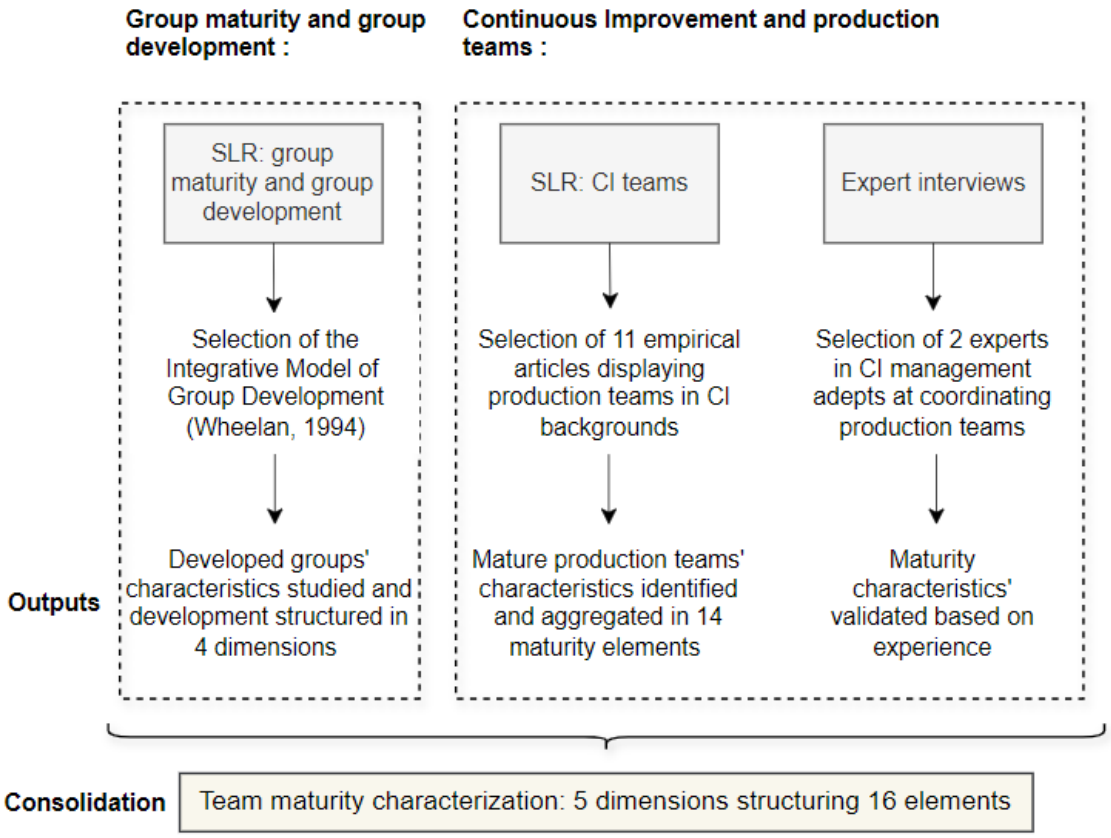

Figure 2.4 : Methodological steps overview for team maturity characterization.

The consolidation of the 3 research phases leads to the identification of 16 maturity elements. The sources for defining the 16 maturity elements are illustrated in Figure 2.5. The 14 maturity elements derived from the CI literature (Table 2.5) were confronted with the IMGD literature. It appears that 8 maturity elements were addressed by both the CI literature and the IMGD. Besides, these elements were also confirmed by CI experts:

- Communication openness;
- Collaboration;
- Autonomy level;
- Performance level;
- Shared goals;
- Participatory problem solving;
- Roles organization in the team;
- Trust.

In contrast, 6 maturity elements were absent from the IMGD literature (Table 2.3), but are significant for production teams in CI contexts, according to the CI literature and CI experts.

- Shared meaning;
- Shared values;
- Performance monitoring between members;

- Collaboration with other teams and departments;
- Communication with other teams and departments;
- Communication openness with the program manager.

Moreover, 2 maturity elements were not covered by the CI literature, but are recognized as significant traits of developed groups, according to the IMGD (Table 2.3). As they were later recognized in the CI experts' speeches, these 2 elements were included in our list:

- Conformity;
- Conflict management.

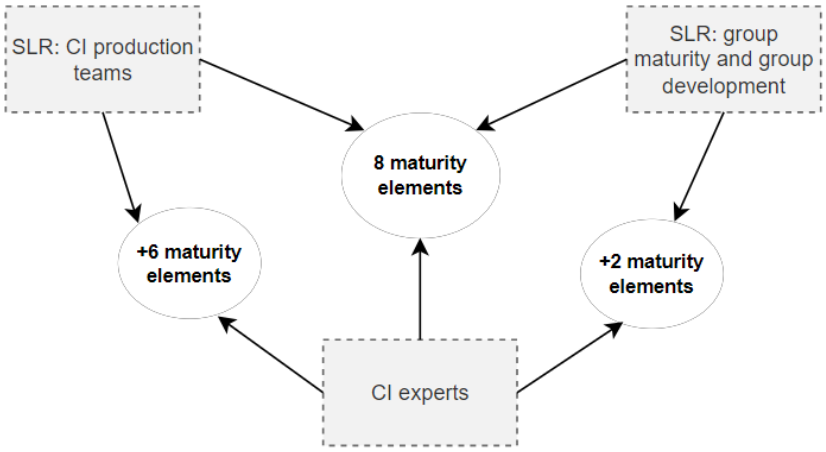

Figure 2.5 : Sources for the 16 maturity elements.

Thereafter, the 16 maturity elements derived from the aforementioned sources (Figure 2.5) were categorized into the 4 original dimensions derived from the IMGD (Group Behavior, Communication, Members' relationship and Work Level). Most maturity elements identified in CI literature align with these 4 maturity dimensions. However, a fifth dimension was included to the characterization, to address the External Relationships of teams with other teams, departments and managers. This new dimension encompasses the elements related to the team's collaboration and communication with other teams and with the program's manager.

In conclusion, a team maturity characterization composed of 5 dimensions and 16 maturity elements was retained and is depicted in Figure 2.6.

In essence, the adopted approach for the characterization of CI production teams' maturity - incorporating SLR from 2 distinct disciplines and expert opinions - ensures the robustness of the proposed team maturity characterization. **The thorough methodology has resulted in a well-defined and clearly structured framework of 5 maturity dimensions and 16 maturity elements. Moreover, by integrating insights from diverse sources and focusing on empirical evidence, the team maturity characterization provides a comprehensive understanding of maturity of CI production teams, while also laying a solid foundation for developing effective assessments aimed at enhancing team maturity in CI contexts.**

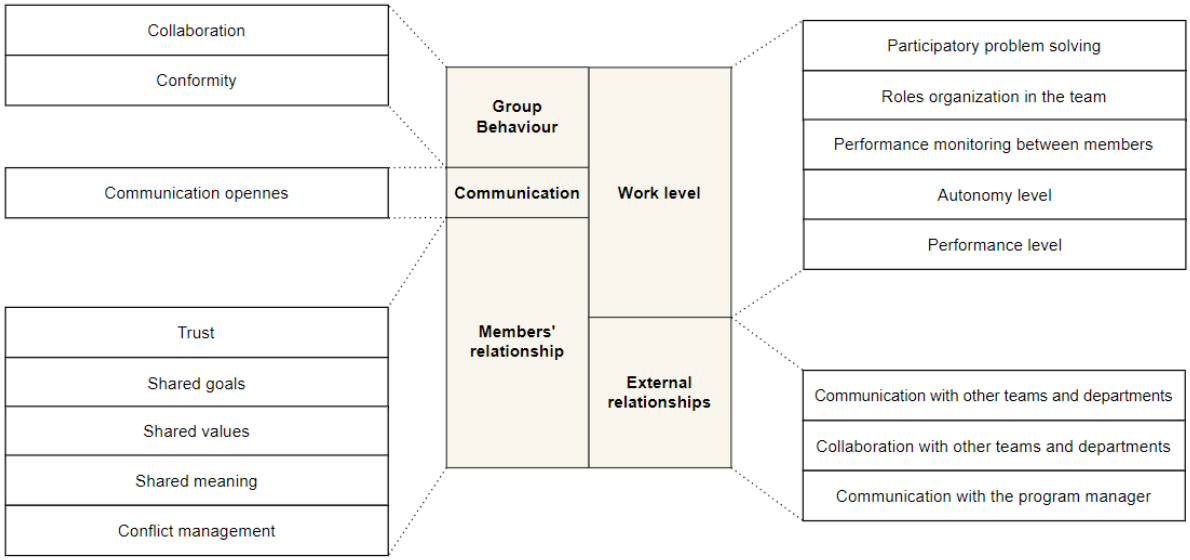

Figure 2.6 : Team maturity characterization.

2.6. Description of maturity dimensions and elements

The following subsections present a description of the maturity dimensions and their respective elements, clarifying what is included within each concept.

2.6.1. Group behavior

Behavior is associated with actions (Cambridge Dictionary, n.d.). Additionally, the American Psychological Association (2018) defines group behavior as "*actions performed by a group as a whole or by individuals when part of a group*". In this context, group behavior is defined as the actions of a group within a specific setting.

Recognizing the broad nature of the term "*behavior*", a deliberate distinction was made to isolate behaviors directly related to the specificities of CI contexts, which were categorized under a separate maturity dimension (Work level). This decision aimed to clarify and facilitate the understanding and analysis of distinct dynamic processes within groups. In this light, 2 maturity elements pertain to the group behavior dimension:

- **Collaboration:** this maturity element is associated with teamwork, members' inclination to collaborate, peer support, and cooperation and respect within the team. It also reflects positive interpersonal relationships and cohesiveness within the team.
- **Conformity:** mature groups have a strong voluntary conformity to organizational rules and practices. The team acknowledges and aligns its behavior with the company's internal policies and practices.

2.6.2. Communication

Communication is the process of transmitting messages or information from one person to another, and the exchange of information or expression of feeling that can result in mutual understanding (Communication, n.d.). For Colazo (2016), communication patterns in CI teams are indicators of other team characteristics, and important team outcomes. Furthermore, the author affirmed that as CI progresses, communication patterns fundamentally change within teams, between teams, and between production teams and management.

In a corroborative manner, groups experience various communication patterns before reaching a state of openness, where all members actively participate (Wheelan, 1994). Therefore, this maturity dimension includes only one element:

- **Communication openness:** refers to a high level of open communication, regular recognition of achievements among members, a strong degree of information sharing between members and the consistent exchange and effective use of quality feedback among members.

2.6.3. Members' relationship

This maturity dimension enfolds the quality of interactions between team members and the nature of the connections they establish and maintain. It also reflects how members engage with one another. Relationships among members significantly impact the team's overall dynamics, including their cohesiveness and members' well-being. From this perspective, 5 maturity elements were categorized under this dimension:

- **Trust:** concerns the level of confidence and reliability that members place in one another. It is the foundation of strong interpersonal relationships.
- **Shared goals:** refers to the shared understanding of team goals, strategies and priorities. It is essential that these goals are clearly defined and managed collaboratively, ensuring that all members have a common grasp of the objectives, the approach, and the ambition to achieve them.
- **Shared values:** highlight the collective principles that guide members in their daily work activities. These values should include self-transcendence values, which focus on caring for the well-being of others, such as altruism, benevolence, and a desire to assist others, and openness-to-change values, which are related to a proactive attitude towards change and a willingness to embrace new ideas.
- **Shared meaning:** involves the significance that members attribute to their work and their comprehension of its value and purpose. Through the creation of a shared meaning, team members gain an understanding of the importance of their contributions and the underlying reasons behind their efforts. This comprehension enhances their commitment to quality, increases the value they place on performance improvements, and fosters a stronger sense of ownership and belonging.

- **Conflict management:** in mature groups, conflicts are both common and brief due to effective conflict management strategies. Successfully resolved conflicts promote healthier interactions among members and stronger relationships.

2.6.4. Work level

This dimension encompasses how teams participate in CI activities, which ultimately reflects on their performance. In CI settings, teams are expected to go beyond their prescribed tasks and actively seek opportunities for improvement.

In CI contexts, progress, whether large or small, is achieved through the application of tools and techniques designed to identify and resolve issues while minimizing waste and variations (Singh & Singh, 2015). Thus, 5 maturity elements are present in this dimension:

- **Participatory problem solving:** refers to the active involvement of team members in collectively planning work processes and resolving issues, ideally through a structured problem-solving methodology. Participative decision-making enhances members' ability to effectively analyze and address problems, further encouraging proactive behavior within the team.
- **Roles organization in the team:** involves the clear definition of responsibilities and roles, ensuring that every team member understands and agrees on their specific tasks. The team structure is collaboratively established, ensuring that everyone is aware of its own role and the roles of others, fostering alignment and mutual understanding.
- **Performance monitoring between members:** refers to the regular and systematic evaluation of individual and team performance, where members consistently review and discuss their own results. This practice promotes a collective sense of responsibility for the team’s performance and improvement. Thus, it can be further facilitated through designated meeting spaces and transparent communication from management.
- **Autonomy level:** encompasses the degree of independence or dependence that teams have on program managers, as well as the extent of participation and empowerment afforded to teams. Self-directed team activity demonstrates the team's capacity to manage tasks autonomously, and indicates reduced reliance on management for routine decisions and problem-solving.
- **Performance level:** addresses team performance with a focus on ongoing process improvement, which is a primary goal in driving operational excellence. The presence of multi-skilled workers enhances team flexibility and supports the formation of multifunctional teams. In addition, the continuous improvement of team members' skill levels is also desired.

2.6.5. External relationships

External links between different teams are particularly important in CI settings. Teams should actively communicate and exchange important information that helps them improve their processes, facilitating knowledge sharing. Teams must collaborate when needed or appropriate, whether in a daily task, or for an interdisciplinary project.

In addition, positive external relationships among teams can also promote a supportive and satisfying work environment. Finally, there are 3 maturity elements in this dimension:

- **Communication with other teams and departments:** involves the extent and effectiveness of communication between different teams and departments, including the development of communication networks that are crucial for CI success and sustainability.
- **Collaboration with other teams and departments:** encompasses the level of cooperation between teams and departments, including horizontal integration and cross-functional teamwork. It also involves fostering mutual respect and understanding across different teams and departments.
- **Communication openness with the program manager:** focuses on the interaction and exchange of information between teams and organizational management. This element emphasizes the importance of transparent, timely, and constructive communication flowing vertically within the organization.

2.7. Synthesis

While the significance of human factors and production teams for CI programs' success and sustainability is widely acknowledged, prior studies have not yet explored the maturity of these teams to support CI. Our research addresses this literature gap, offering a thorough examination of production teams' maturity.

Since teams can exhibit different characteristics based on their context or objectives, a team maturity characterization (Figure 2.6) is meant to capture the particular traits of production teams operating within a CI setting. In this sense, the characterization was constructed based on extensive literature search and field specialists' opinion.

To ensure construct validity, besides combining multiple sources of data, the characterization comes from a chain of evidence that transitioned from a broader context to a specific CI context (Yin, 2013). Indeed, the team maturity characterization provides a comprehensive view of CI production teams' maturity, as it evolved from studying diverse groups through the lenses of various disciplines to a more focused, CI-specific analysis, thus allowing the development of a more accurate and highly adapted construct.

From a theoretical standpoint, the analysis and structuration of Wheelan's (1994) IMGD into identified dimensions, and the association of 2 different literature backgrounds (group development and CI) represent significant contributions to the respective fields of group development and CI research.

The concept of general progression over time, drawn from group development research, offered a foundation for constructing this characterization. In this sense, the parallel evolution of the 4 identified dimensions is reflected in the interconnectedness of maturity elements. For instance, in line with Wheelan and Hochberger (1996), Conflict management plays a critical role in building structure within the group. Since Roles organization is also a maturity element, this highlights an intrinsic connection between the two.

Moreover, as illustrated in Figure 2.5, each maturity element is supported by at least 2 distinct sources, with most elements being corroborated by all 3 (groups SLR, CI SLR, and CI experts). This alignment demonstrates a consistent pattern in the traits associated with group maturity across the sources, and underscores the robustness and consistency of our construct, highlighting the convergence of insights from diverse perspectives.

Overall, this thorough methodology led to the development of a **team maturity characterization for CI production teams, consisting of 5 maturity dimensions and 16 maturity elements.** This framework offers a comprehensive view of CI production teams and provides a **solid foundation for developing effective assessments aimed at improving team maturity to support CI initiatives**.

By integrating this developmental perspective with defined maturity elements, a team maturity assessment can be structured to evaluate each element and measure its progression individually within the group. Therefore, the result of the assessment can be used to design targeted actions to enhance specific maturity elements of CI production teams.

Chapter 3

Toward a Conceptual Team Maturity Improvement Process to support CI initiatives

Chapter Overview

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Our objective is to provide organizations with a foundation to assess and improve team maturity, thereby enabling production teams to become the transmission force behind the success and sustainability of CI programs. To accomplish this, we move beyond the static approach of identifying the defining elements of team maturity in CI contexts, to adopt a more dynamic perspective that acknowledges its potential for development and transformative nature.

The chosen group development perspective (section 2.3.2) suggests that team maturity emerges as an implicit outcome of time. In this sense, regardless of how time affects team maturity - leading to growth or regression, or if teams can move back and forth through development stages - viewing team maturity as a developmental process is particularly relevant for improvement objectives. In this context, considering team maturity as a result of an ongoing team process enables its effective management.

This viewpoint suggests that team maturity can be systematically assessed and managed. In other words, this approach allows for planning and implementing targeted actions to improve team maturity. From this perspective, Figure 3.1 presents a Conceptual Team Maturity Improvement Process (CTMIP), which is grounded in the literature discussed in the preceding chapters:

- Sections 2.5 and 2.6: the identification of maturity elements suited to production teams in CI contexts reflects team dynamics. These elements emerge through the interactions between team members.
- Sections 1.2 and 1.3: maturity exhibits an intrinsic cyclical effect, and it influences, and it is influenced by it, people and the environment. There is a reciprocal relationship between team member maturity and team maturity, and teams can amplify individual contributions while mitigating the negative impacts of CI. In addition, teams play a greater role in determining organizational outcomes. Through synergistic effects, they can accomplish results that exceed the sum of members' abilities.

The primary focus is improving the maturity of existing CI production teams, rather than changing its members. Thus, although the initial maturity levels of team members affect overall team maturity, they cannot be changed in our context. Nevertheless, actions aimed at enhancing team maturity will consequently promote improvements in the individual maturity of team members as well.

In this light, the conceptual structure presented in Figure 3.1 allows us to clearly present and organize our premises, providing a visual representation that emphasizes the main subjects of this chapter: the assessment and improvement of team maturity.

This chapter is organized as follows: Section 3.1 details the Conceptual Team Maturity Improvement Process. Section 3.1.1 introduces the assessment part, including a team maturity model and an accompanying assessment approach. Section 3.1.2 focuses on team maturity improvement, highlighting intervention axes and maturity influencers that can be leveraged to develop targeted improvement actions. Lastly, Section 3.2 provides a synthesis of the findings and outlines directions for future research.

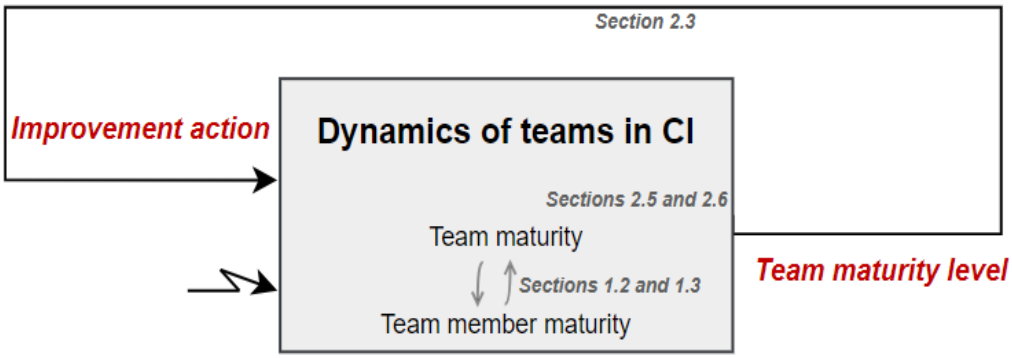

Figure 3.1 : Conceptual Team Maturity Improvement Process (CTMIP)

3.1. A Conceptual Team Maturity Improvement Process

Although firms often resort to changing personnel regarding production teams, our objective is to highlight that production teams can achieve greater outcomes if their maturity is effectively managed. Moreover, various studies have already examined group composition in CI contexts, such as Tortorella *et al.* (2021), who investigated the influence of demographic characteristics in production teams to sustain initiatives.

Improving the maturity of production teams to support CI initiatives represents an innovative approach that aligns with the recommendations of Cropanzano (2009) and Gilson and Goldberg (2015) regarding the importance of establishing conceptual models.

In this sense, the Conceptual Team Maturity Improvement Process (CTMIP), presented in Figure 3.1, serves as a conceptual structure that encompasses the identification of team maturity through characterization (section 2.5), along with its assessment and improvement.

Fundamentally, a CTMIP involves assessing team maturity by gathering relevant data on key variables. In this case, the previously identified maturity elements (sections 2.5 and 2.6) can be evaluated by team members through a defined assessment strategy. Subsequently, comparing the results of a team maturity assessment with established maturity targets can facilitate the design of targeted improvement actions.

Moreover, as previously discussed, maturity cannot be directly manipulated like competencies; however, contextual factors significantly influence its development (section 1.3.1). Identifying the factors within the organizational scope affecting team maturity can also facilitate the creation of targeted actions to improve it.

In summary, effectively managing the maturity of production teams - improved over time through assessments and targeted interventions - enables firms to achieve success and sustainability in their CI efforts. If maturity is a state that can be cultivated and enhanced over time, the same applies to team maturity. Thereby, a mature workforce promotes a complete integration of the CI philosophy, and fosters a positive environment that also endorses overall satisfaction and well-being.

3.1.1. Team maturity assessment

3.1.1.1. A team maturity model

For Kohlegger *et al.* (2009), "*a maturity model conceptually represents phases of increasing quantitative or qualitative capability changes of a maturing element in order to assess its advances with respect to defined focus areas*". The authors further explained that maturity models can be applied descriptively, explaining changes observed in reality, or normatively, to enhance effectiveness or efficiency of managers or stakeholders' interventions regarding the maturity development of maturing elements.

Becker *et al.* (2009) proposed a structured method to develop a maturity model, and their method outlines essential criteria to ensure robustness, and considers aspects such as the model's scope, purpose, completeness, and clarity (Wagire *et al.*, 2021). Their rigorous methodology is grounded in a strong theoretical foundation from design science research and has been widely adopted ever since (Schumacher *et al.* 2016; Bertolini *et al.*, 2019; Wagire *et al.*, 2021). In essence, Becker *et al.*'s framework presents a multi-methodological strategy to develop a maturity model that incorporates literature review, comparison of other maturity models, external validation, modeling and conceptual design, as well as testing and validation in real-world applications.

In this sense, the development of the proposed team maturity model respected the procedures of Becker *et al.*'s, employing their systematic step-by-step approach. On this basis, a flowchart illustrating this development process is provided in Figure 3.2, and then explained in detail, clarifying the methodological steps involved.

According to Becker *et al.*'s, the development of a maturity model begins with a clear problem definition. In our case, the purpose was to evaluate the maturity of production teams functioning within CI contexts. Initially, it is necessary to establish the relevance of the issue at hand. As discussed in previous chapters, this evaluation is pertinent, given that the success of CI initiatives depends heavily on production teams.

Subsequently, it is necessary to compare existing maturity models to confirm the need for a new one, and to establish an effective strategy for its creation. This investigation revealed that no existing maturity models address the same objective, and no existing models offer a detailed view of team dynamics or incorporate the direct perspectives of production workers within CI contexts.

Therefore, the development strategy was set at developing a maturity model centered on team dynamics, with an assessment aimed at directly capturing team members' evaluations regarding the quality of these interactions.

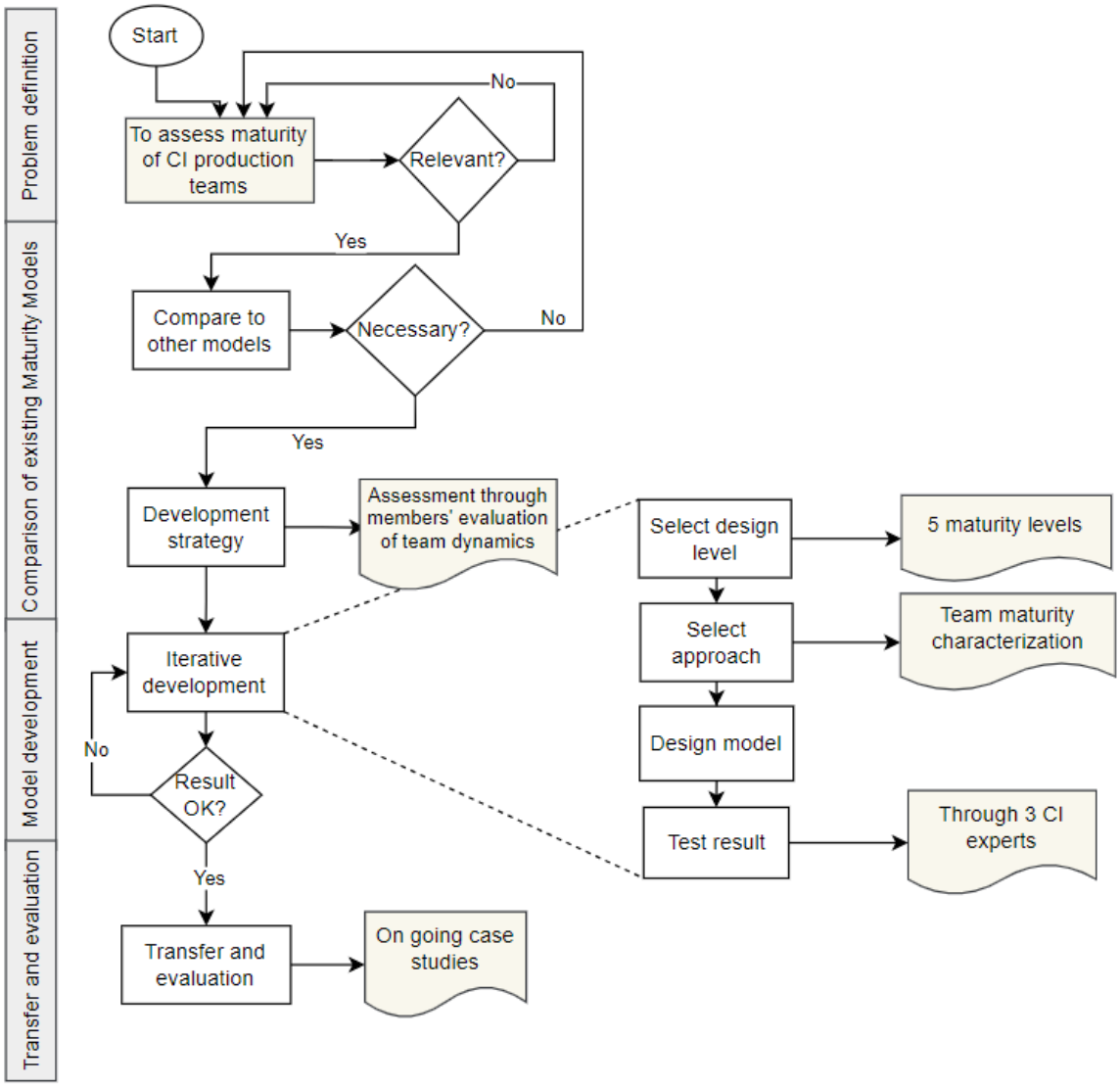

Figure 3.2 : Development of a team maturity model based on Becker et al.'s methodology.

Moving forward and reaching the development phase, the subphases - selecting the design level, selecting the approach, designing the model and testing the results - are iterated. We determined 5 levels of team maturity (initial, reliant, reactive, efficient and mature), which are described in detail later in this section. Next, to develop the content and shape the model architecture, the selected approach is the team maturity characterization, with its 5 dimensions and 16 elements. The resulting model architecture was tested by 3 field experts for comprehensiveness, problem adequacy and consistency This phase did not lead to changes in its initial overall architecture.

The choice to adopt 5 maturity levels was based on insights gained from exploring other maturity models. Specifically, our approach incorporates concepts from the Capability Maturity Model (CMM, section 1.3.2), where, at the fifth and highest maturity level, processes enter a phase of continuous improvement. The CMM introduced the notion of increasing capabilities: reaching a particular maturity level ensures the requisite maturity to advance to the next one. In our case, teams progress through the maturity levels by transforming their interactions, practices, and their perception of themselves as a

unified team. As this progression unfolds, each maturity level marks a shift in how the team behaves, communicates, its internal and external relationships, and how it approaches work.

To test the result model, we opted for external validation from 3 experts who have over 15 years of experience in CI transformations, 2 of whom also have academic backgrounds. On average, the semi structured interviews lasted 45 minutes each. The experts confirmed the relevance and feasibility of the maturity model, noting that its elements comprehensively address team maturity in CI contexts. The experts also validated the maturity levels, and had some suggestions to add to their definitions that were later incorporated. In summary, the maturity model received highly positive feedback and was approved by the 3 experts.

The final phase of the procedure involves establishing dissemination strategies, and was addressed in the form of scientific publications and envisioned through case studies with companies to compare anticipated benefits with real-world outcomes. These case studies are discussed in chapter 4.

As a result of Becker *et al.*'s steps, the model architecture is depicted in Figure 3.3 and consists of 5 maturity levels: initial, reliant, reactive, efficient and mature. The criteria for determining a team's maturity level are consistent with the team maturity characterization, encompassing 5 dimensions and 16 maturity elements.

The 5 maturity levels represent thresholds, with each one translating into a corresponding outcome. During an evaluation, the team's level is compared to a predefined target within the 5 maturity levels, and the *Mature level* is a state of full maturity in which production teams sustain CI.

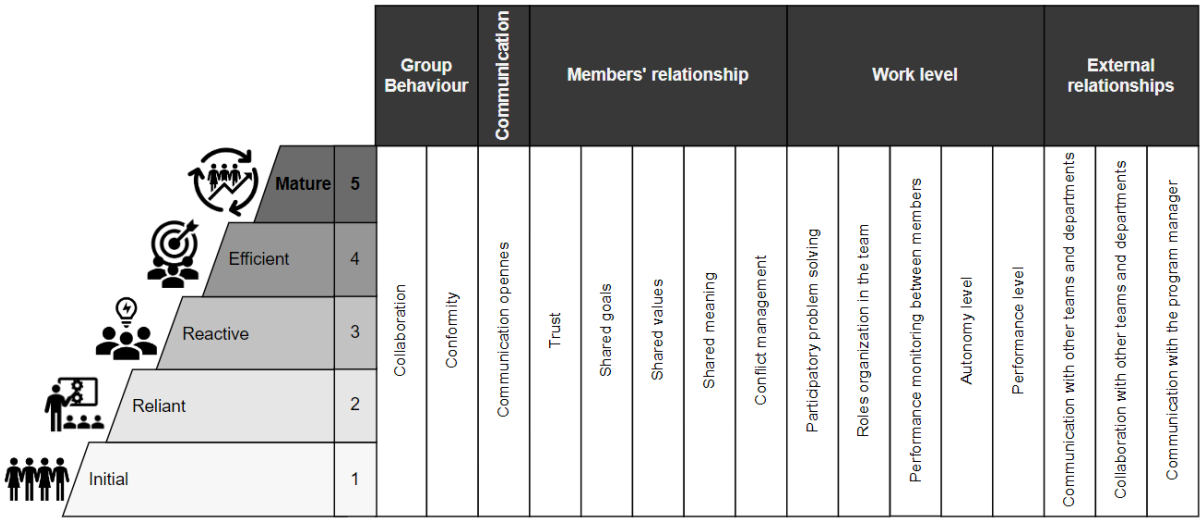

Figure 3.3 : Team maturity model.

A description of the 16 maturity elements and 5 dimensions is provided in section 2.6. Regarding the 5 maturity levels, they are outlined as follows:

- **Initial level:** the team does not exhibit any practices indicative of maturity, functioning more as a group of individuals working in the same space rather than a team. There is an absence of structure, and a lack of awareness or engagement with processes that promote growth, resulting in minimal team outcomes.
- **Reliant level:** this level reflects a dependence on management or external factors for maturity practices to emerge. While there may be sporadic manifestations of maturity practices, their occurrence is inconsistent and not fully integrated into the team's dynamics, which leads to limited team outcomes.
- **Reactive level:** the team demonstrates the capacity to implement mature practices in response to specific situations. However, it remains reactive rather than proactive. This suggests that improvements may occur, but they are often situational and not part of a systematic approach or collective commitment to CI.
- **Efficient level:** the team demonstrates effectiveness and consistency in applying mature practices and can be considered a cohesive unit. These practices are regularly integrated into daily operations, leading to enhanced processes and reliable methods that support performance improvements.
- **Mature level:** the team enters its more mature level, and thus a phase of continuous improvement, as mature practices are deeply embedded in the team culture. At this level, there is a strong commitment to CI and growth is actively pursued by the team.

At last, the team maturity model delineates the levels of maturity, and can be supported by a questionnaire to measure progress through those levels, thus determining a maturity level and enabling an assessment of team maturity.

3.1.1.2. A self-assessment approach

Performing an assessment involves "*the process of considering all the information about a situation and making a judgment*" (Cambridge Dictionary, n.d.). According to Liborio-Zapata (2022), assessments often complement maturity models. The clearly defined milestones within a maturity model facilitate the judgment process, enabling the determination of a position within the model.

The team maturity model defines 5 levels of maturity and encompasses 5 dimensions structuring 16 maturity elements. In simple terms, the 16 elements represent the criteria that define team maturity; or each element reflects a dynamic of the team that, together, compose its overall maturity. All in all, each element can be assessed individually according to the maturity levels.

Moreover, the goal is to assess team maturity through the evaluation of all its members. Collecting input from each member individually is important to avoid biases (group pressure, for example) and to engage everyone directly in reflecting on their team's maturity.

In this sense, team members are presented with each maturity element, along with 5 possible levels for evaluation (initial, reliant, reactive, effective and mature). The selected levels reflect a judgment of the team's maturity in relation to specific maturity elements. This is logical, as a single team can exhibit

different maturity levels across distinct elements. Thus, the average of all maturity evaluations across the different maturity elements reflects the overall assessment of the team's maturity.

Our objective is to make the assessment as straightforward as possible for both the team members and those interpreting the results. This approach facilitates a clear, comprehensive view of team maturity in the following ways:

- The average of all 16 evaluations from a single team member reflects their assessment of the team's overall maturity;
- The average of all team members' evaluations for a single maturity element reflects the overall maturity level of that single element;
- The average of all team members' evaluations across all 16 elements provides a complete picture of the team's overall maturity.

Furthermore, this approach provides insights into the homogeneity or heterogeneity of the team by analyzing the variation in members' evaluations.

3.1.1.3. Implications

There is a significant gap in assessment tools for evaluating soft factors in CI settings, especially concerning production teams, which have been largely overlooked. This research aims to address this deficiency in CI literature by developing a team maturity model and an assessment approach to evaluate the maturity level of CI production teams, based on the judgments of team members.

From this viewpoint, the maturity assessment relies on members' self-evaluations of their team dynamics, offering stakeholders an internal perspective and a new source of context and information to support decision-making. Consistent with this standpoint, some authors underscore the significance of context for the effectiveness of workforce management actions (Hersey & Blanchard, 1993; Buzaglo & Wheelan, 1999; Poksinska *et al.*, 2013; Tortorella *et al.*, 2015).

Furthermore, the team maturity model and assessment are grounded in empirical evidence derived from the team maturity characterization, addressing the concerns of Tarhan *et al.* (2016) regarding the robustness of maturity models. Additionally, the external validation conducted by 3 experts directly responds to concerns of Helgesson *et al.* (2012) and Tarhan *et al.* (2016), who emphasize the importance of both internal and external evaluations before testing a maturity model in real-world settings. Altogether, 5 experts in CI management contributed to the CI production teams' maturity construct, as they validated the team maturity characterization and maturity model.

Finally, the structure of the team maturity model, organized into dimensions and elements, offers a flexible approach to evaluating maturity. Assessing all elements within a dimension allows for an evaluation of that dimension, while a dimension-based view of maturity results proves valuable when assessing maturity of multiple teams. Moreover, gathering input from all members ensures that all perspectives are considered for a complete and well-rounded assessment.

The team maturity model and an associated assessment serve as a valuable tool for management strategies supporting CI, facilitating the prioritization and implementation of targeted improvement actions focused on specific maturity elements or dimensions.

3.1.2. Team maturity improvement

3.1.2.1. Mapping of axes of intervention and team maturity influencers

The team maturity assessment results facilitate the identification of maturity elements in need of improvement. In essence, this information allows for the establishment of targeted objectives, whether focused on a single maturity element or multiple ones. Therefore, a well-structured action plan for enhancing team maturity can be developed, implemented, monitored, and refined accordingly.

From this perspective, pinpointing improvement actions that directly reinforce a specific maturity element is challenging, as many actions tend to have a broader impact across multiple elements. For example, while proposing problem-solving training may be designed to enhance a particular maturity element such as *Participatory problem solving*, it is likely to influence other maturity aspects as well, such as *Collaboration*, *Autonomy*, and potentially more.

This interconnectedness between maturity elements highlights the complexity of designing improvement actions and the potential for broader organizational benefits beyond the initial target. To illustrate this phenomenon, Table 3.1 presents 2 studies that were used to identify maturity elements in the team maturity characterization (Table 2.4). These studies also clearly revealed connections among maturity aspects, thus indicating their intricate interdependencies.

Table 3.1 : Interconnections between maturity elements.

Authors	**Interconnections among maturity elements**
Lantz *et al*. (2015)	"Proactivity is enhanced in teams through learning processes and participatory decision-making, and inter-team collaboration. Collaboration with other teams was significantly associated with the team's change initiative and building a shared sense of work"
Hansen *et al.* (2020)	"For collaboration to be successful, effective communication among team members is necessary, and lack of crust can hinder timely and direct communication among team members. High quality of work has a positive impact on the commitment and trust between team members, which has a positive effect on the direct lines of communication"

Furthermore, the literature can only offer limited insight into the consequences of management actions taken to address team maturity elements. Indeed, the effectiveness of any management action is highly contextual: external and internal factors can influence whether a given strategy will succeed or fail.

From this viewpoint, rather than determining a list of improvement actions for single or multiple maturity elements, we identified main factors associated with enhancing overall team maturity in the IMGD (section 2.3.2) and the SLR of CI production teams (section 2.4.1).

Thus, this analysis led us to identify 3 distinct axes of intervention and 11 maturity influencers. The axes of intervention are the main areas within an organization's structure or environment that impact maturity of teams, while the maturity influencers are specific focal points within these axes. Table 3.2 outlines these, along with the corresponding literature references that guided their formulation.

Likewise, the interviews conducted with 2 CI experts (section 2.4.3) also uncovered factors impacting team maturity. While most of these were identified in the literature (Table 3.2), others had not been detected yet. Notable aspects emphasized by both experts included managerial transparency and active listening from management, which aligns with the Organizational context axis, and relates to the maturity influencers Organizational practices and Management support, respectively.

The formulation of intervention axes and maturity influencers can benefit the development of an improvement plan by guiding management in generating targeted actions that align with their specific needs. By contemplating these axes and influencers within their operational context, managers can contemplate and define relevant actions tailored to their circumstances.

Table 3.2 : Axes of intervention and influencers of maturity

Axes of intervention	Maturity influencers	References and recommendations
Work conditions	Security	Minor accident occurrence [5]; Implementing a safety method that involves pointing and verbally stating important actions or information to enhance awareness and reduce errors [5].
	Infrastructure	The group has a defined work territory [1]; Building a common coffee and lunch area [9]
	Working hours	Workers on a full-time basis [6; 10]; Eliminating night work if possible [9];
	Team Size	The group contains the smallest number of members necessary to accomplish its goals, ensuring that team leaders maintain a manageable span of control [1; 7; 8; 4].
	Task appropriateness	Tasks contain variety and challenge [1]; Tasks are appropriate to group versus individual solution [1]; Role assignments match member abilities [1].
Resources availability	Training	Employee training [2]; The group has access to technical or human relations training as needed [1].
	Access to resources	The group has access to the technical and people resources necessary to accomplish its task, and to technical or interpersonal experts as needed [1]; Resources for CI practice [10].
	CI maturity	CI maturity [10]; Whiteboard meetings and standardized procedures on deviations [9]; Presence of a formally recognized and active team leader [8]; CI instructor's support [6].
Organizational context	Organizational practices	Strategic and structural clarity [10]; Skills competition and awards for improvements [5]; Empowerment, delegation and participation in decision-making [1; 8; 3]; Promptly addressing sick leave issues [9];
	Culture	Controlling that time and performance pressure do not increase excessively [7]; Supporting goal awareness and communication between team members [7]; Values of self-transcendence and openness to change of high-level leaders [3]; Cultural change [2].
	Management support	The leadership style matches the group's developmental level [1]; Time on the production floor and frequent face to face support [9; 10]; Managerial support for change [9; 2]; Team recognition or team valorization [5; 2].

1- Wheelan and Hochberger (1996); 2- Jaca *et al.* (2012); 3- Lantz *et al.* (2015); 4- Van Dun and Wilderom (2016); 5- Wang *et al.* (2016); 6- Nasim and Iqbal (2019); 7- Hansen *et al.* (2020); 8- Tortorella *et al.* (2021); 9- Halling *et al.* (2021); 10- Van Dun and Wilderom (2021).

3.1.2.2. Association of maturity dimensions and elements with team maturity influencers

The development of an improvement plan is directly tied to the results of the team maturity assessment. In this sense, we aligned the maturity dimensions and elements with key team maturity influencers to illustrate important relationships between them.

As noted earlier, team maturity influencers and related improvement actions can simultaneously affect various maturity elements, and Figure 3.4 presents what we believe to be some important connections between them.

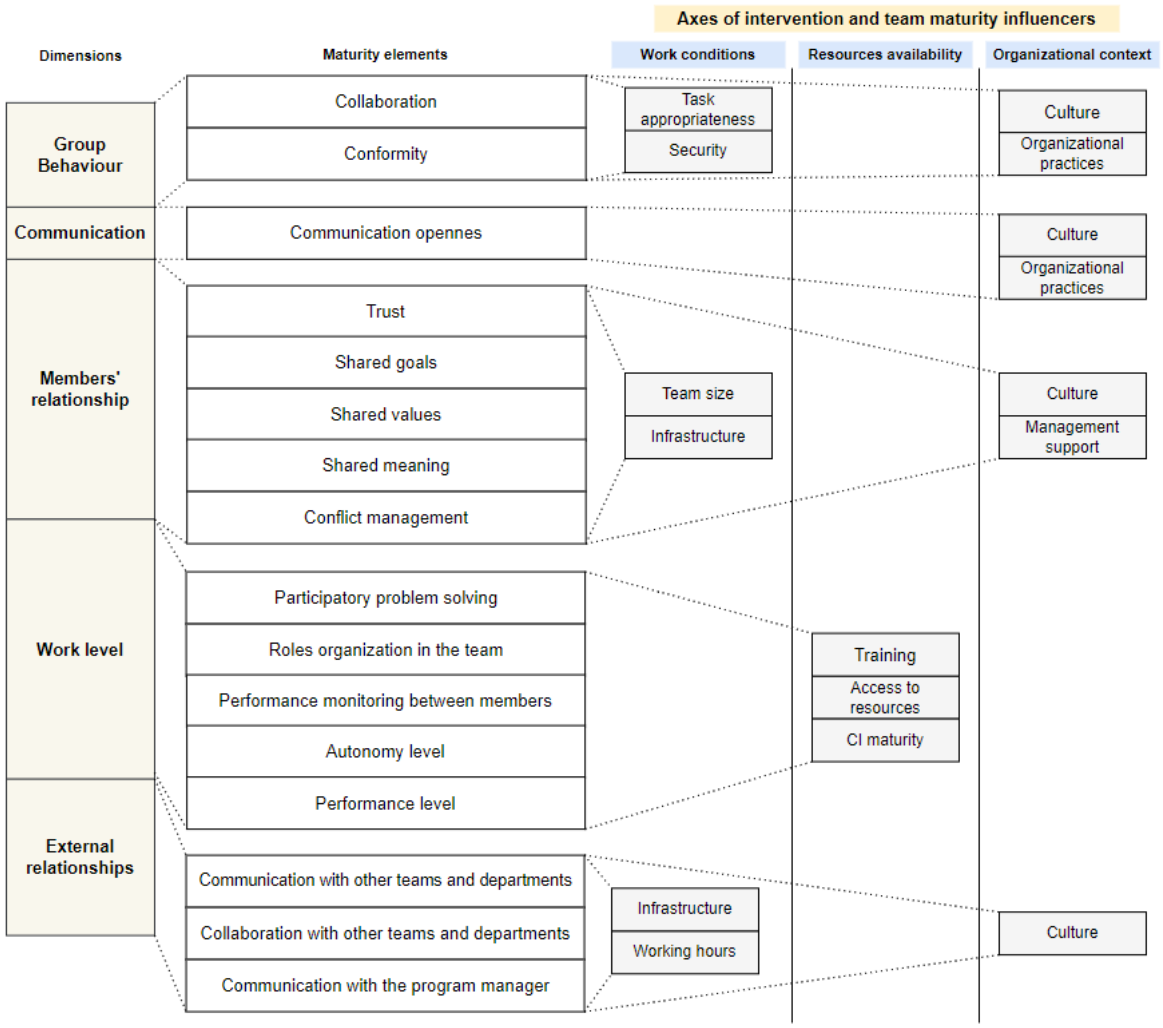

Figure 3.4 : Maturity influencers associated to maturity dimensions and elements.

However, it is important to note that while these relationships were identified in our research, they remain speculative, as there is no definitive evidence to guarantee that any specific action pertaining to a maturity influencer will enhance a particular maturity dimension or element. Moreover, these connections represent only a fraction of the broader potential impacts that related improvement actions may have.

The following paragraphs delve into these connections, providing further details of how related actions can play a role in enhancing maturity dimensions and elements.

In the **Group behavior** dimension, actions related to Task appropriateness, Security, Culture and Organizational practices can positively influence team *Collaboration* and *Conformity*. If tasks offer little opportunity for team *Collaboration*, managers can introduce variety through initiatives like improvement challenges, encouraging team members to work together and support one another. A positive culture that promotes values of self-transcendence, such as mutual assistance among employees, further nurtures *Collaboration* and *Conformity*, as these principles are ones that individuals can easily embrace. Additionally, Security measures and clear Organizational practices that communicate policies, as well as a shared vision and mission will further strengthen *Collaboration* and *Conformity* within the team.

In terms of **Communication**, the company's Culture and Organizational practices concerning transparency and communication channels are essential for promoting an open dialogue. By fostering an open communication culture across different hierarchical levels, and promoting transparency in communication between management and production teams, the organization encourages *Communication openness* within the team.

For **Members' relationship**, actions related to Team size, Infrastructure, Culture and Management support can foster *Trust*, *Shared goals*, common *Values* and *Meaning*, as well as aid in possible *Conflicts*. Smaller teams increase the chances of members developing *Trust* and sharing *Goals*, *Values* and *Meaning*, and limit potential *Conflicts*. Additionally, establishing defined work areas and common spaces for lunch and coffee breaks can strengthen relationships among team members. A Culture that promotes positive values, such as openness to change and self-transcendence, combined with a CI instructor who maintains a balanced approach in their interactions with production teams - dedicating 50% of their focus to task-oriented activities and 50% to relationship-building - supports employees to cultivate these maturity elements.

To enhance the **Work level** of teams in a CI setting, actions related to Training, Access to resources and CI maturity (for example, to ensure standardized procedures for improvement) can significantly influence *Participatory problem solving*, *Roles organization*, *Performance monitoring*, *Autonomy* and overall *Performance*. A CI training focused on problem-solving can develop various maturity aspects within the team. A mature CI program with well-defined standards for addressing issues, clear metrics, and designated program manager is essential. By providing access to these resources, including control metrics, team members can effectively *Monitor performance* of members and team, and quickly respond to any issues and assist their colleagues when necessary. This approach also fosters *Autonomy* within the team. In addition, encouraging the team to designate a team leader can enhance *Roles organization* and *Autonomy*, and leadership can be rotative based on specific improvement projects or tenure.

In the **External relationships** dimension, actions related to Infrastructure, Working hours and Culture can significantly influence *Communication* and *Collaboration* of teams *with other teams and departments* and *Communication with the CI program manager* or instructor. An infrastructure that includes not only common break areas for employees, but also opportunities for social activities outside

of work, can help them strengthen their relationships, and this familiarity can encourage more effective *Communication* and *Collaboration* among employees from different teams and departments in work-related contexts. In addition, workers who share the same Working hours and are employed full-time tend to demonstrate greater commitment and engage more actively with one another. Besides, a culture that promotes cooperation and dialogue across various hierarchical and departmental levels, coupled with a CI program manager or instructor who actively listens to team members, reinforces these maturity elements.

3.1.2.3. Implications

Based on the literature references that contributed to the formulation of the maturity influencers (Table 3.2) and the experts' interviews (section 2.4.3), a set of 20 general team maturity improvement actions is depicted in Figure 3.5 and associated with the axes of intervention and team maturity influencers. These general actions can serve as a supplementary resource to assist in the creation of a customized plan.

This set of actions can assist managers, fostering their creativity and stimulating idea generation during brainstorming sessions, for instance. It can also serve as a checklist, allowing managers to evaluate actions' relevance within their specific contexts.

The identification of 3 axes of intervention and 11 team maturity influencers, accompanied by a set of 20 example actions derived from literature and interviews with CI experts, provides valuable guidance for managers in developing their improvement plan to enhance maturity of production teams within CI contexts. Moreover, the association of team maturity influencers with maturity dimensions and elements can contribute to discussions and aid managers in prioritizing actions based on the maturity outcomes they aim to attain.

Each team operates within a distinct social setting that sets its circumstances apart. In this regard, the team maturity assessment (section 3.1.1.2) can include an open-ended question where team members share suggestions for improving maturity elements, thereby adding another layer of information and context to it. Team members are well-positioned to identify and express their needs, providing management with an insider's perspective. This perspective enriches understanding of the team's realities, supporting the development of a tailored and effective improvement plan.

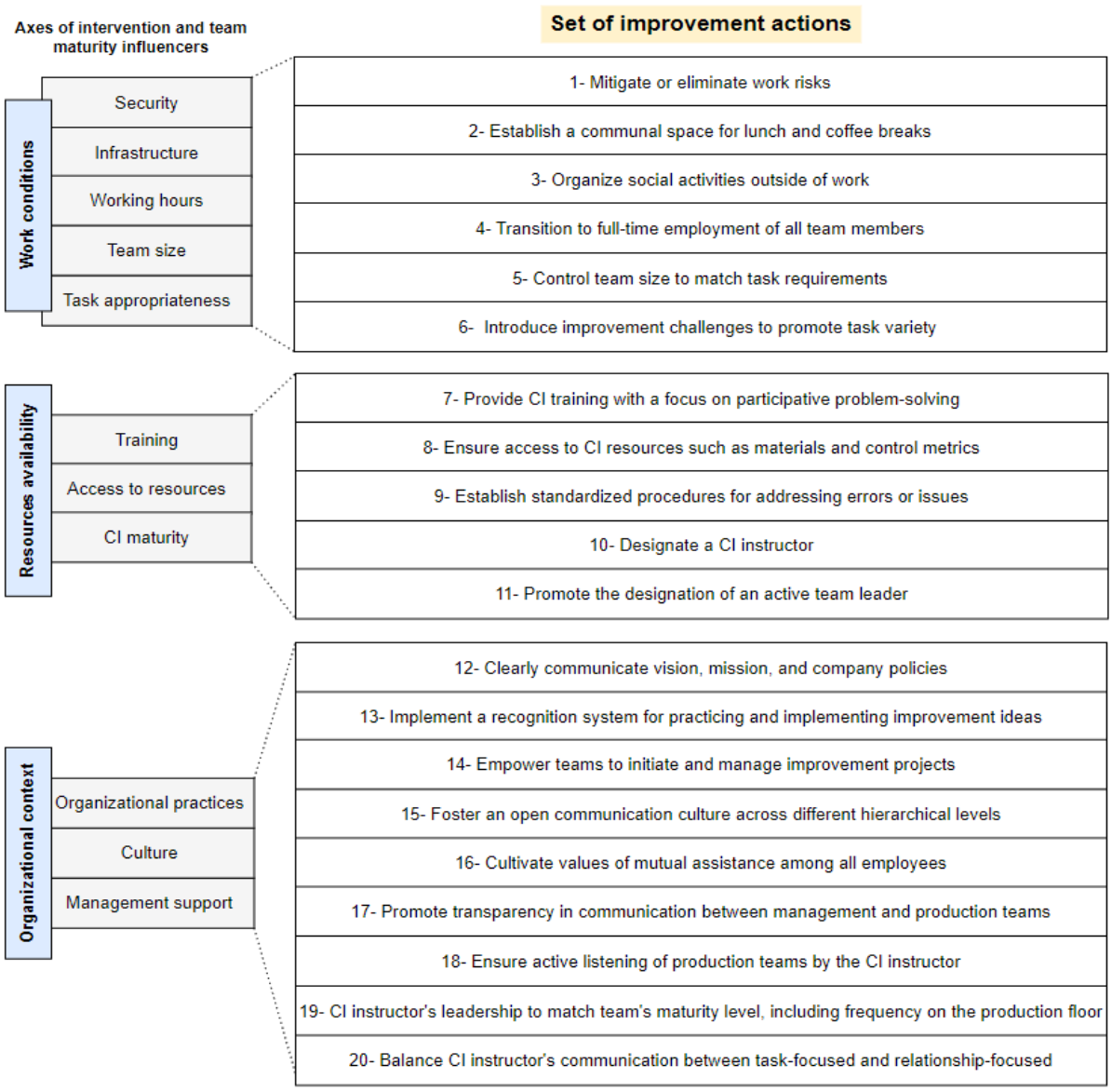

Figure 3.5 : A set of improvement actions related to the intervention axes and team maturity influencers.

3.2. Synthesis

Our research focuses on how to assess and improve the maturity of production teams to better support CI initiatives. Nonetheless, prior to addressing these aspects, it was imperative to first identify the characteristics of a mature team capable of sustaining CI efforts - a step addressed in the previous chapter through a team maturity characterization.

Thus, the Conceptual Team Maturity Improvement Process (CTMIP) serves as a conceptual structure that encapsulates the research objectives of identifying, assessing, and improving the maturity of production teams in CI contexts. Our study is organized around these 3 phases, with the CTMIP providing a clear articulation of our goals and a visual representation of our approach. In this sense, Figure 3.6 revisits the CTMIP, highlighting the results achieved within the 3 components of interest.

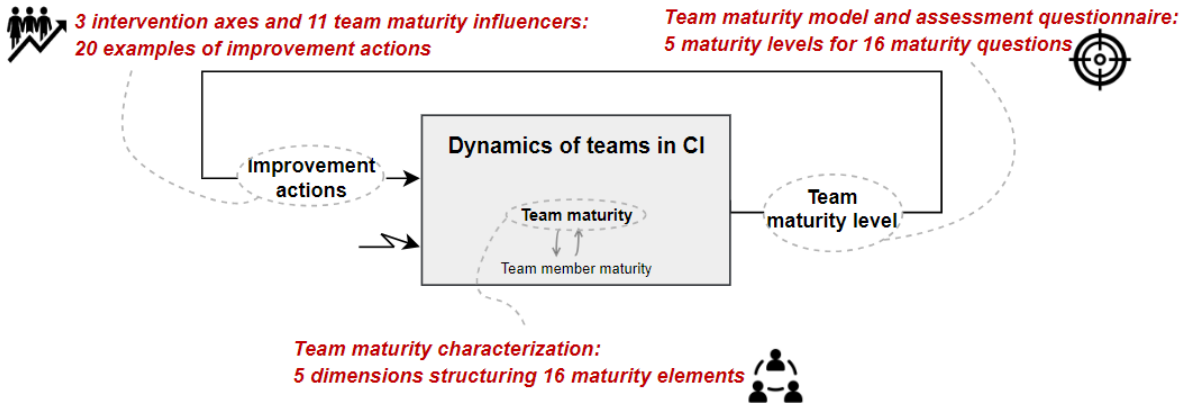

Figure 3.6 : Revisited Conceptual Team Maturity Improvement Process (CTMIP)

In the assessment phase, we developed a maturity model and an assessment approach grounded on empirical evidence and external validation, thus addressing concerns that maturity models may oversimplify reality and lack a solid empirical foundation. Furthermore, many maturity models face criticism for being purely descriptive; they should provide guidance on improvement measures to reach higher maturity levels (Röglinger *et al*., 2012). In this context, the CTMIP fulfills this crucial normative role by integrating assessment and improvement. The results from the assessment can be leveraged to enhance maturity elements through their connections with intervention axes and maturity influencers.

Embedding assessments and improvement actions into the organizational culture is a fundamental standard of CI programs - what sets the CTMIP apart is its innovative and mutually beneficial team maturity approach. However, if the CTMIP approach is not effectively diffused, production teams may perceive a maturity assessment as just another control tool, rather than an opportunity for growth and enhanced satisfaction and well-being.

In this sense, it is essential to clearly communicate the purpose of the maturity assessment and follow through with improvement actions. Collecting team members' evaluations of team dynamics and their suggestions for improvement is an acknowledgement that their insights are important. However, if management fails to cultivate voluntary support or to act on feedback, the approach intended to foster open dialogue and improve relationships between both parties could be compromised.

A CTMIP approach encourages team members to reflect on their own development, which can engage and empower them to take ownership of their maturity process. Similarly, De Vries and Van der Poll (2018) highlighted production teams that overcame the challenges of maintaining a productive team dynamic - described as the most difficult aspect of CI initiatives - by reflecting on the underlying causes and consequences of these obstacles. Additionally, potential benefits of a CTMIP include the opportunity to conduct internal benchmarking among teams that exhibit higher maturity levels than others in very similar contexts.

Furthermore, a more significant contribution to the literature on maturity models would stem from their actual application. De Bruin and Freeze (2005) stress the importance of deploying maturity models in independent entities from their development to ensure generalizability, and Röglinger *et al*. (2012) call

for more clarity on how, where, and by whom these models should be applied. In this sense, it is pertinent to develop a formal protocol for the case studies.

Against this background, practical tests of a CTMIP would require more research resources for tracking interventions longitudinally. However, if the benefits of a CTMIP approach are confirmed, it could be easily transferred and implemented in organizations without necessitating extensive resources. Moreover, practical applications could also lead to identifying more relevant or specific actions related to maturity elements or dimensions and evaluate their effectiveness. Overall, it is important to advance beyond the theoretical development of a CTMIP and evaluate the tangible impact of this approach on real-world CI initiatives.

Chapter 4

Proposal of a team maturity assessment: Insights from case studies

Chapter Overview

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The development of the Conceptual Team Maturity Improvement Process (CTMIP) in the previous chapter clearly presents our research approach: identifying the maturity of production teams in CI contexts to assess and ultimately improve it. This process was developed through a robust theoretical background, informed by a thorough investigation of team maturity, empirical evidence from existing literature, and insights from CI experts. With this foundation in place, the natural next step in our research is to test the approach in real-world settings, assessing its viability and effectiveness with actual teams.

From this perspective, implementing practical tests of the CTMIP requires sufficient time to establish the improvement phase. As discussed in Section 3.1.2.1, improvement actions often have a broad impact across multiple maturity elements, and their effectiveness is highly dependent on context. Therefore, effective team maturity improvement must be tailored to each specific context, considering existing company practices and identifying actions that are both feasible and effective.

Given the limited timeframe available for this practical research phase, this chapter focuses on proposing applications specifically related to the team maturity model and the self-assessment approach (sections 3.1.1.1 and 3.1.1.2). Moreover, the development of a maturity model requires practical deployment to test its generalizability. These tests should offer precise guidelines on applying the model, clarifying how, where, and by whom it can be implemented, ensuring a thorough evaluation of its viability and relevance across different contexts.

Therefore, this chapter showcases the practical application of the team maturity model and assessment approach, along with an evaluation of their relevance for assessing maturity of production teams and supporting CI initiatives.

The chapter is organized as follows: Section 4.1 introduces the case study methodology, providing details on the adopted method for conducting the studies. Section 4.2 presents the selected cases, which are further described in Section 4.3 through case reports. Section 4.4 offers a cross-case analysis, detailing the evaluations of the maturity assessments in real cases, insights into maturity results, and an optimal protocol for team maturity assessment. Finally, Section 4.5 presents the conclusions.

4.1. Case study research method

Yin (2013) defines case studies as "*an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident.".* Moreover, he further notes that case studies are a comprehensive research strategy, particularly suited for researchers who do not wish to exercise control over behavioral events, and seek to study contemporary rather than historical events. In other words, case studies are pertinent for an in-depth and contemporary investigation of complex phenomena in real-life contexts.

The case study method is best aligned with our research objectives. The team maturity model, along with an assessment, need a detailed investigation to determine their viability and effectiveness in assessing the maturity of real-world production teams. Furthermore, organizational contextual

differences can significantly impact the outcomes of applications, and thus are a crucial source of information regarding the model's adaptability. An overview of the case study methodology adopted in this research is depicted in Figure 4.1.

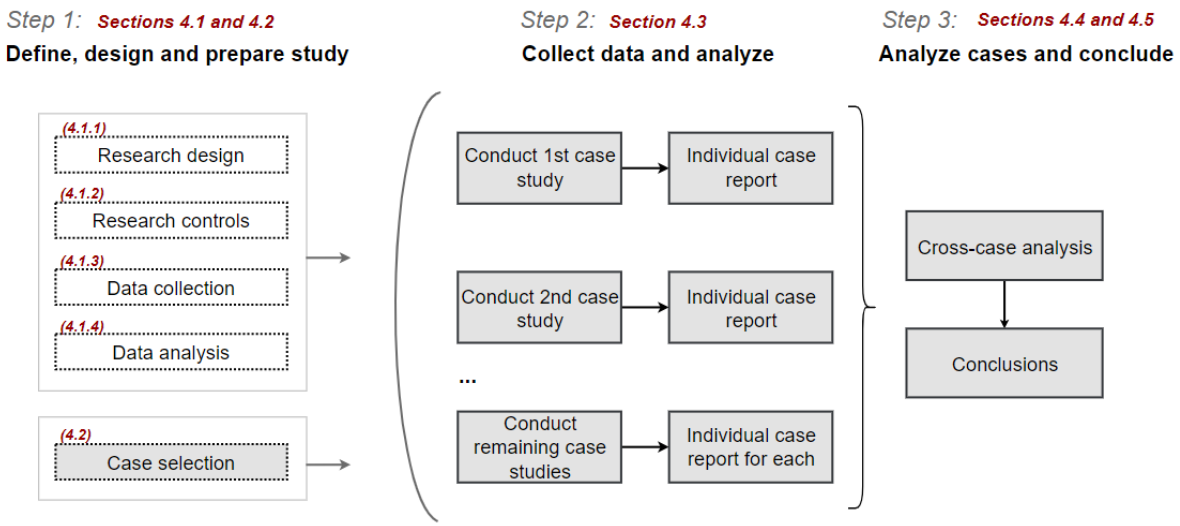

Figure 4.1 : Case study methodology overview, based on Yin's (2013) recommendations.

Case studies require researchers to clearly define the research design, controls, data collection methods and data analysis techniques to increase validity and reliability of the findings. The remainder of this section is dedicated to outlining these preparatory steps taken before selecting and conducting the case studies.

4.1.1. Research design

According to Yin (2013), a research design is a "*logical plan for getting from here to there*". The research design for this study is outlined in the following paragraphs.

The case studies have an exploratory nature. The research purpose is to test and evaluate the practical application of a team maturity model and assessment approach with actual production teams operating in CI contexts. The assessment is envisioned through the subsequent development of a questionnaire designed to be completed by team members. The goal is to determine the pertinence of the team maturity model for companies involved in a CI initiative, thereby determining each of these companies as the unit of analysis for the study.

The researchers aim to conduct multiple case studies. For the sampling strategy, purposive sampling is employed to select companies based on their relevance to the research objectives. Regarding replication logic, case studies in different companies are designed to cover different organizational contexts, thus theoretical replication is expected.

4.1.2. Research controls

A set of research controls was formally defined and is outlined below. Regarding case selection, the focus is on companies that are established in France, regardless of their sector or activity, as long as they are actively engaged in CI efforts and have production teams operating within this environment.

- Location: companies in France;
- Context: companies engaged in a CI initiative;
- Target participants: production teams operating within a CI initiative.

A production team refers to the teams responsible for different stages of operational processes. Companies may have multiple production teams, each focused on specific tasks or phases within their manufacturing or service delivery operations.

For data collection, the fundamental controls that must be upheld are:

- Individual responses: each team member is required to complete an assessment questionnaire individually;
- Anonymity: team members should not be identifiable when collecting the completed questionnaires.

To better conduct the assessment, it is important that the participants understand its purposes. The following control is set:

- Assessment introduction: a clear explanation of the assessment is required prior to distribution for the respondents, detailing its objectives, the measures taken to ensure anonymity, and the estimated time for completion which was set at 30 minutes.

Altogether, these research controls represent the fundamental standards for conducting the multiple case studies and aim to enhance research reliability, alongside a data collection protocol (section 4.1.3.2).

4.1.3. Data collection

The primary data collection instrument is an assessment questionnaire designed for team members to evaluate team maturity. Additionally, a data collection protocol concerns the administration of this questionnaire to teams within the case companies.

Furthermore, after assessing the teams through the questionnaire and obtaining the maturity results, a semi-structured interview is planned with the company to gather feedback on the maturity assessment and results, as well as to understand the application process.

4.1.3.1. Assessment questionnaire

The assessment questionnaire is designed for members of production teams to evaluate the team based on their individual perceptions. Additionally, the questionnaire is developed in french. Figure 4.2 illustrates its 5 sections, further detailed in the following paragraphs. Section 3 addresses the primary objective of this study, which is the team maturity assessment through members' evaluations.

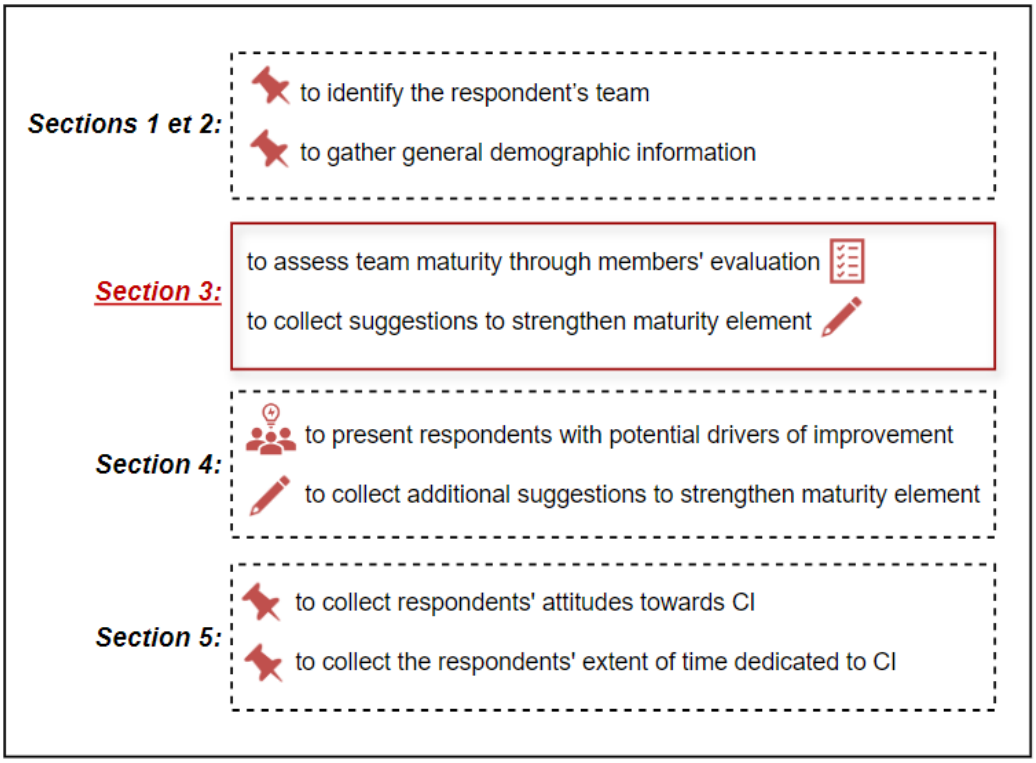

Figure 4.2 : Breakdown of the assessment questionnaire sections.

Initially, the questionnaire provided potential respondents with details about the study, an estimated completion time (~30 minutes), and information regarding the confidentiality of the collected data. Moving forward, **the first and second sections** of the questionnaire are designed to identify the respondent's team, ensuring that responses from the same team can be compiled later on, and gather general demographic information:

- **Team identification** (adapted for each case study as either a guided or open-ended question, depending on the specific situation);
- **Age group** (guided question with 5 possible options: 18 to 25 years, 25 to 40 years, 40 to 55 years, and over 55 years);
- **Seniority in the company** (guided question with 5 possible options: less than 1 year, 1 to 3 years, 3 to 10 years, and more than 10 years);
- **Seniority in current team** (guided question with 5 possible options: less than 6 months, 6 months to 1 year, 1 to 3 years and more than 3 years);

- **Duration of participation in Continuous improvement** within or outside the current team (guided question with 5 possible options: less than 1 year, 1 to 3 years, 3 to 8 years, more than 8 years).

The third section focuses on assessing team maturity by capturing members' evaluations of team dynamics. It includes 16 questions, each corresponding to one of the 16 maturity elements. For each question, respondents are presented with 5 options that reflect the application of the 5 maturity levels (section 3.1.1.1) within each maturity element.

Furthermore, the response options also integrated concepts derived from the literature and experts' interviews that compose the descriptions of the maturity elements. The goal was to offer more context and information, including examples, to help respondents better position themselves. In general, the application of the 5 maturity levels to the maturity elements also followed the definitions:

- Option 1: the maturity element is completely absent from the team;
- Option 2: the maturity element can randomly manifest within the team;
- Option 3: the team can apply the maturity element in response to specific situations;
- Option 4: the team consistently reproduces the maturity element;
- Option 5: the maturity element is deeply rooted or part of the team spirit.

Moreover, the response options were deliberately designed to reflect the different levels of team maturity in how they addressed the respondents. The first 2 options, corresponding to maturity levels 1 and 2, refer to 'team members,' while the subsequent options, maturity levels 3, 4 and 5, consistently use the term 'the team'. As team maturity progresses, the notion of 'the team' as a unit increases. Figure 4.3 presents an excerpt of the questionnaire: an english translation of one of the 16 maturity questions. In addition, the order of the maturity questions was determined to enhance respondents' comprehension.

11) Which statement best reflects **problem-solving** within the team?
□ the team members never solve problems together.
□ the team members can solve a few specific problems together, but in a disorganized way.
□ the team tends to solve important problems together.
□ the team solves problems in a participatory and methodical way, and makes decisions collectively when necessary.
□ the team shares problem-solving and decision-making processes that are clear, methodical, and participatory. They are part of the team's mindset and spirit.

Figure 4.3 : Excerpt from the Assessment Questionnaire.

Moreover, an open-ended question was included right after each one of the 16 maturity questions, inviting team members to share their suggestions for improving the respective maturity element within the team. This format provided respondents an opportunity to openly express their opinions. In total, the 16 open-ended questions followed the structure below, but adapted to the concerned maturity element:

- In your opinion, what actions could strengthen *Collaboration* within the team?

Subsequently, a **fourth section** was developed to present respondents with potential drivers of improvement within teams, including training, resources availability for CI practices, and management support. This section aimed to highlight a few general drivers, enabling respondents to share any additional ideas they might have to strengthen maturity within their teams. Following this, one question was posed:

- Do you have any additional ideas of actions to strengthen the maturity elements within the team?

Finally, **the fifth and last section** of the questionnaire aimed to capture respondents' attitudes toward CI in their professional activity, and the extent of time dedicated to it with 2 close-ended questions:

- **State of mind regarding CI in the professional activity** (guided question with 4 possible options: “what is this thing?”, “I have a rough idea of its purpose…”, “I regularly have ideas for improvement (feasible or not)”, “I dream about it at night”);
- **Proportion of time devoted to continuous improvement** efforts in the professional activity (guided question with 5 possible options: less than 10%, 10% to 30%, 30% to 60%, 60% to 90%, 90% or more)

After its development, the questionnaire was validated by the same 3 experts who reviewed the maturity model (section 3.1.1.1). All experts conveyed a positive opinion regarding the purpose of the questionnaire, but provided remarks that led to adjustments, particularly in language, to enhance accessibility and clarity for the respondents. The experts raised concerns that the maturity options were overly long, leading us to seek a balance between conciseness and depth of content. We assumed that this issue can also be alleviated by the five-level scale, which allows respondents to select a position even if they do not examine each option in detail. Finally, the complete questionnaire is provided in Appendix 1: Assessment questionnaire.

4.1.3.2. Data collection protocol

In conducting the assessment, companies were given flexibility within the framework of the established research controls and the administration of the questionnaire was left to their discretion. The research team was available to introduce the assessment questionnaire and explain the study to the respondents; however, companies had the option to manage the process independently. For example, companies decide whether respondents complete the questionnaires together in a designated area under supervision

or individually at their convenience if they are distributed for later collection. They should also determine whether to administer the questionnaire in paper format or digitally, in a platform of their preference, as both options were possible. At last, the completed questionnaires are then submitted to the research team.

Recommendations were offered to the companies, emphasizing the importance of full team participation and creating an environment conducive to honest and open responses. These factors are crucial for improving the accuracy of a team maturity assessment. In this light, the goal was to observe how the companies would appropriate the team maturity study and conduct the assessment.

4.1.3.3. Semi-structured interview to collect company feedback

A semi-structured interview is planned to occur after a report with the assessment results is provided to the companies and is structured around 4 key points of inquiry: the assessment process, the questionnaire itself, feedback on the results and the pertinence of a team maturity assessment. Further details regarding the information sought are outlined as follows:

- Assessment process: complete account of the questionnaire's administration, including their evaluation of the chosen method; potential issues or challenges faced; identification of problematic items in the assessment questionnaire; teams' reactions to the assessment; and evaluation of the feasibility of the study for production teams.
- Coherence of results: alignment of the results with perceived reality; evaluation of result relevance and potential contributions to the CI dynamic; and any perspectives on potential refinements to the overall approach of assessing team maturity of production teams.

4.1.4. Data analysis

The data analysis is structured in 2 phases: first, analyzing the individual cases, and second, performing a cross-case analysis.

For the individual cases, the objective is to construct an Assessment Report for each company, based on the data analysis of the assessment questionnaire, further detailed in section 4.1.4.1. Following the distribution of this report to the companies, the analysis of the semi-structured interview data (section 4.1.3.3) is oriented toward compiling and systematically detailing the feedback provided by each company about the study implementation.

Thereafter, the individual cases are compared side by side, and a cross-case analysis is performed to draw final conclusions about the feasibility of the team maturity assessment and viability of the maturity study.

4.1.4.1. Construction of an Assessment report

The goal is to deliver a clear and informative report to each company presenting the results of the maturity assessment. Thereby, all data from the assessment questionnaires are organized in an Excel file - the responses to the close-ended and open-ended questions - and then imported to Power BI for analysis. Power BI facilitates the calculation of means, dispersion metrics and offers flexibility in managing diverse datasets from various teams. Furthermore, it is an effective tool for data visualization and generating graphs to create reports.

The Assessment report is customized for each organization, incorporating data collected from respondents across the 5 sections of the assessment questionnaire (Figure 4.2). This includes the identification of participant teams, along with donut charts depicting their demographic information, attitudes toward CI, and time dedicated to CI activities. Most importantly, it presents the maturity results based on respondents' evaluations of team maturity, elaborated upon next, and it summarizes their suggestions for enhancing the maturity elements. As multiple teams can participate in the study within each case company, the report also includes a cross-analysis of teams in similar contexts designed to underscore key findings in the maturity results. Figure 4.4 presents the main information included in the report, illustrating the layout of some graphs for clearer visualization.

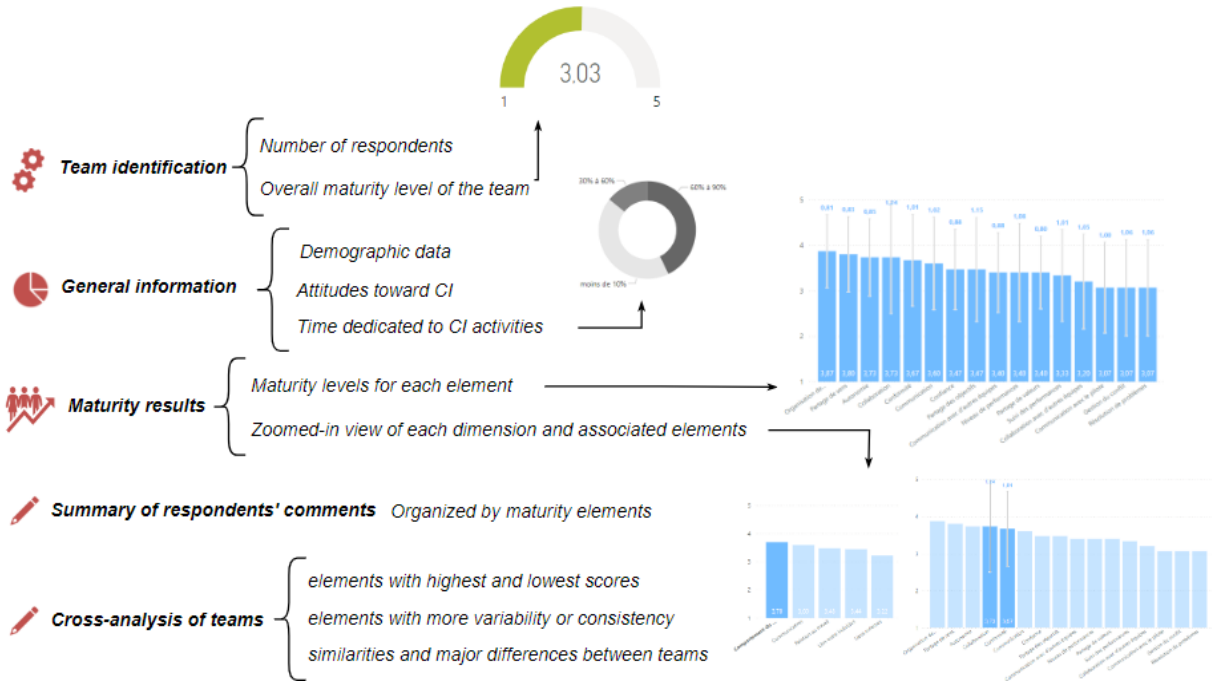

Figure 4.4 : Main sections of the Assessment report.

The Assessment reports are structured by layers: an overview of teams in the same production context, followed by individual team maturity results. A radar chart is also included to enable easy visualization and comparison of maturity levels across teams. Figure 4.5 displays a radar chart with data from hypothetical teams, illustrating its layout. Further details on the results included in the report are discussed in the following paragraphs.

For the maturity results, the report presents each production team with a maturity profile detailing the overall maturity level of the team and the maturity level for each maturity element, rated on a scale from 1 to 5. The report presents a detailed view for each of the 5 dimensions, highlighting the maturity level of the dimension as well as the maturity levels of the elements it encompasses. These ratings reflect the responses of team members, who perform their evaluation of maturity selecting one of the 5 response options in the assessment questionnaire.

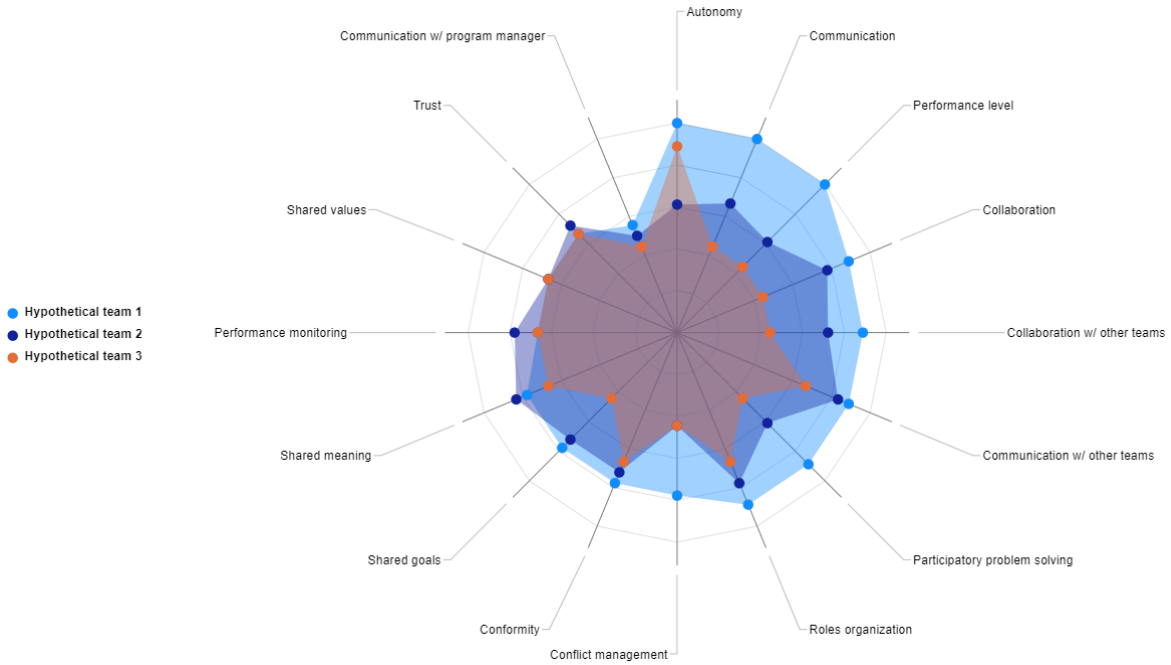

Figure 4.5 : Illustration of a sample radar chart of maturity elements.

In this light, the overall maturity level is determined by calculating the average of all team members' responses to the 16 maturity elements. Moreover, the maturity level of each dimension is calculated as the average of responses for the maturity elements within that dimension, allowing a more nuanced understanding of each maturity area. Similarly, the maturity level for each specific element is determined by averaging the responses from all team members related to that element, enabling a clear view of the team's strengths - elements with higher maturity scores - and areas of concern - elements with lower maturity scores.

Additionally, the report includes details on response dispersion, emphasizing the total variability among team responses according to the overall maturity average, as well as the variability for each specific maturity dimension and element. This information reveals areas of strong consensus as well as notable divergence among team members.

Overall, the analysis of team maturity results aims to highlight elements with the highest and lowest scores, as well as areas of significant variability or consistency in responses. It also explores similarities and major differences between teams. For instance, maturity scores from teams on the same work shift and/or production unit can be combined and compared to those on other shifts, offering insights across contexts. Furthermore, all team members' responses are included in all calculations, to ensure accurate

representation, particularly for smaller teams. However, notably unusual responses may also be flagged as part of the analysis.

4.1.4.2. Performing a cross-case analysis

To provide conclusions about the study implementation across cases and explore the viability of a maturity assessment of production teams within CI contexts, the cross-case analysis is organized around 3 main topics:

- Assessment protocols, general results and feedback from the case companies: derived from a parallel analysis of the assessment processes and outcomes across cases.
- Insights on maturity elements: based on a review of maturity results from all participant teams in the study.
- Insights on suggestions to improve maturity of elements: based on the responses of team members to the open-ended questions about ideas to improve maturity elements.
- Toward an optimal protocol for team maturity assessment: constructed from findings regarding the distinct case studies.

4.2. Case selection

The outreach strategies for case selection focused on engaging organizations to encourage participation. To capture their attention, an invitation brochure was designed, visually conveying the study's context, objectives and potential results for participant firms. This communication strategy condensed information in an accessible and appealing format, and was showcased at university events attended by companies and distributed via email. The brochure is displayed in Appendix 2: Invitation brochure for study participation.

Companies expressing interest in the study were then invited to a meeting for a presentation of the research and proposed case study. In all, 6 companies expressed interest in the study and the communication with 3 of them progressed sufficiently in time to enable their participation. The others remain as potential collaborators for future research endeavors.

In general, some additional meetings were necessary with the interested companies, sometimes to present the study to other people beyond the initial contact, but mainly to finalize details of the study, such as explaining the sections and questions of the questionnaire, and aligning the teams to be involved with their respective contexts.

Furthermore, one of the companies could not have its production teams complete the questionnaire. However, because of their early interest and willingness to participate, they conducted the maturity assessment with their 2 CI support teams instead. This pilot application functioned as a training exercise for managing questionnaire data and developing the team maturity report (section 4.1.4.1), but is

excluded from this study because it falls outside the research scope and does not comply with the established controls.

At last, 2 companies were selected as case studies for this exploratory research. One company planned to implement the maturity assessment across 3 distinct production sites in France, and the other on a single production site. The main characteristics of these 2 case companies are summarized in Table 4.1. To maintain confidentiality, they are both referred to by pseudonyms.

Table 4.1 : Characteristics of the selected case companies.

Characteristics	Company E1	Company E2
Industry sector	Mechanical	Mechanical
Staff	Group: > 1000 employees Sites: ~50-200 employees	Group: > 1000 employees Site: ~150 employees
Years in operation	> 100 years	> 100 years

The timeline for both case studies ran simultaneously, with communications with both companies beginning in March 2024. Company E1 administered the assessment questionnaire in April across 2 production sites and in June at a third site. Company E2 administered the assessment questionnaire in July. The maturity reports were distributed to the companies in September, and the interviews to collect their feedback were both held in October 2024.

4.3. Case reports

4.3.1. Company E1

4.3.1.1. Application of team maturity assessment questionnaire

While the study is intended for production teams, the company E1 preferred to assess the maturity of all teams within 3 of its production plants, including those in support functions. Given the study's scope, however, the information presented in this case report focuses exclusively on the assessment of production teams (described in section 4.3.1.2).

Our contact within the company has a role of Director of Continuous improvement and led the team maturity assessment personally in 3 production plants across France. Each plant arranged its own assessment day, gathering production teams in a designated room to complete the questionnaire. To include various participants, 2 assessment sessions were held in each plant during morning and afternoon breaks. The sessions were conducted by our contact in the company. The sessions lasted between 20 and 45 minutes, and began with an explanation of the study and its objectives, and other

important information, such as anonymity and estimated completion time. Thereafter, participants completed the questionnaire in paper format, in the presence of the facilitator, who was available to respond to any questions they might have. Table 4.2 summarizes the characteristics of the protocol adopted to assess team maturity within the 3 production plants.

Table 4.2 : Application of team maturity assessment questionnaire in company E1.

Protocol	**Company E1**
Assessment management	Self-managed
Setting	Respondents gathered in a designated room
Facilitation and support	Initial explanation of the study and facilitator present during completion to assist with possible questions
Duration	~30 minutes
Questionnaire format	Paper

Moreover, the data from the paper questionnaires were first entered into Excel, with approximately half of the data compiled by the company and the other half by the research team. The team maturity report was then crafted and distributed to the company. The following section provides information about the production teams that participated in the maturity study.

4.3.1.2. Teams description and maturity overview

In all, 56 people from 9 production teams completed the assessment questionnaire. Among these, 6 respondents could not be linked to specific teams due to incomplete identification in their questionnaires. Additionally, 3 of the 9 teams had only 2 respondents each, preventing a meaningful analysis.

Therefore, the results of the team maturity assessment within the 3 plants are mainly focused on the remaining 6 production teams, which offer a more robust dataset. These teams are outlined in Table 4.3 and Figure 4.6 illustrates their average maturity levels and total response dispersion.

Furthermore, Figure 4.7 presents the positioning of teams within the maturity model for company E1, displaying the teams' average maturity levels across the 5 dimensions. Presenting the data by dimensions rather than individual elements offers a more concise and clearer overview of each team’s relative standing within the model.

Table 4.3 : Production teams with a significant number of respondents in Company E1.

Production plant	Teams	Number of respondents
Plant 1	E1_1	7 team members
	E1_2	7 team members
Plant 2	E1_3	7 team members
	E1_4	7 team members
Plant 3	E1_5	9 team members
	E1_6	7 team members

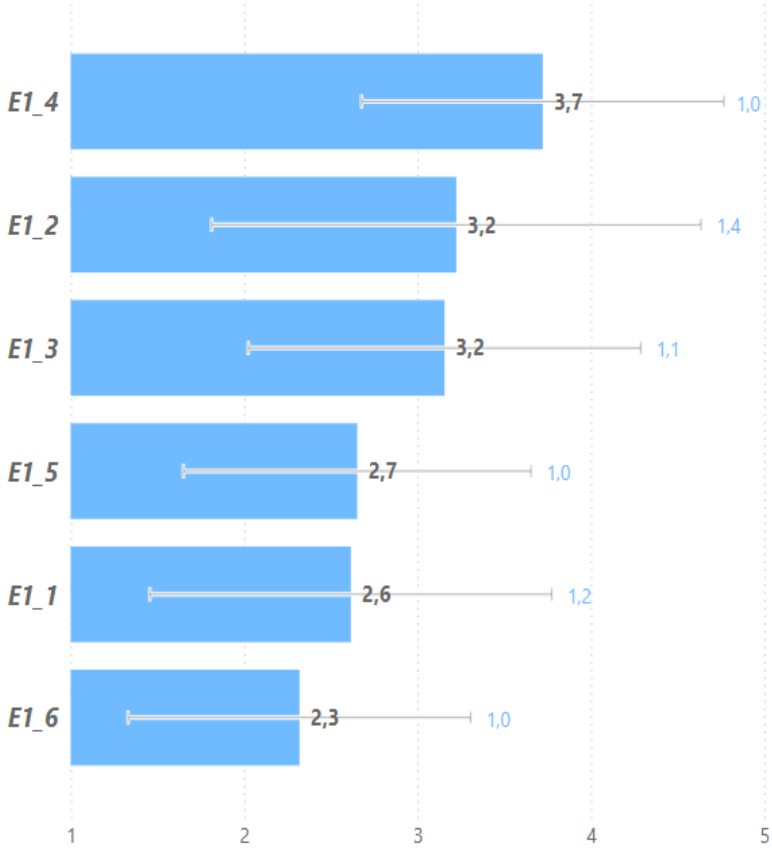

Figure 4.6 : Maturity levels and response dispersion of production teams (company E1).

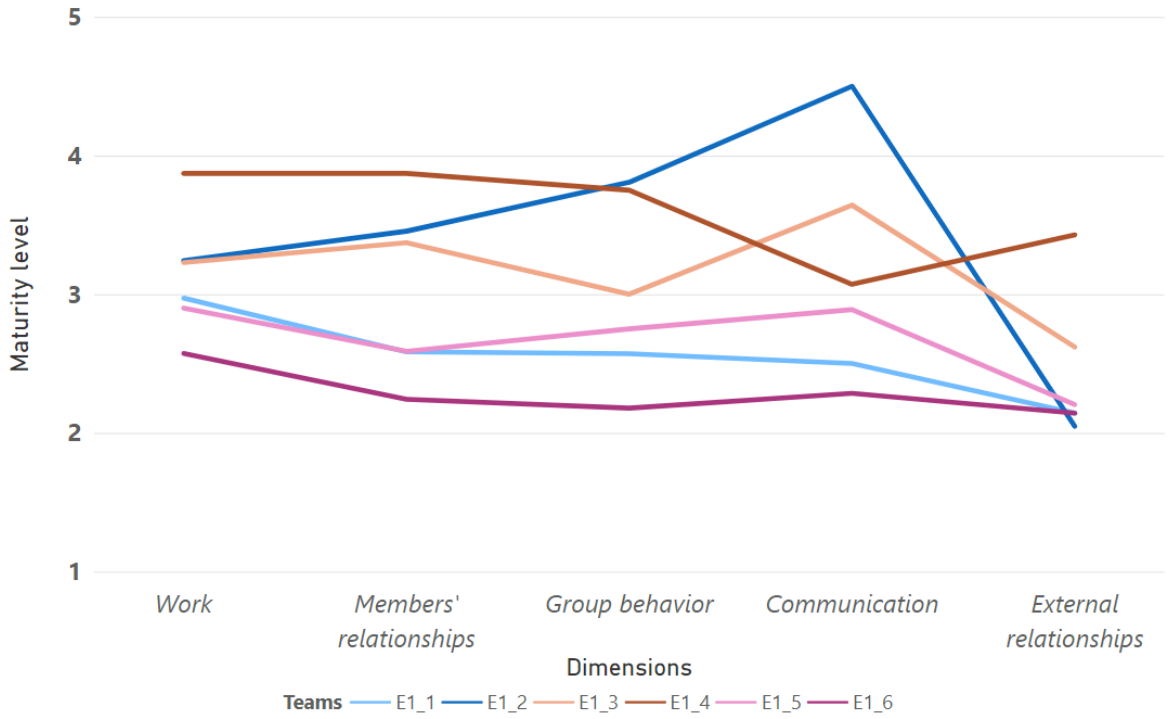

Figure 4.7 : Teams' maturity levels according to the 5 dimensions of the maturity model (company E1).

4.3.2. Company E2

4.3.2.1. Application of team maturity assessment questionnaire

The Operational Excellence management team at the production plant was responsible for conducting the team maturity study within it. They intentionally selected teams operating within 2 specific production units at the plant to participate in the assessment (described in section 4.3.2.2).

The facilitators gathered the participants and administered the maturity questionnaire in 4 sessions. First, an initial explanation about the maturity study was given, and then each question and response option were explained at a time, allowing for participants to answer before proceeding to explaining the next question. The facilitators also provided everyday examples that the respondents could relate to enhance understanding. Each session lasted approximately 45 minutes, and the participants completed the questionnaire in paper format. Table 4.4 summarizes the protocol adopted to assess team maturity within the company.

Moreover, the research team received the paper questionnaires and initially entered all data into an Excel file. The team maturity report was then created and distributed to the company. The next section offers information about the participating teams.

Table 4.4 : Application of team maturity assessment questionnaire in company E2.

Protocol	Company E2
Assessment management	Self-managed
Setting	Respondents gathered in a designated room
Facilitation and support	Initial explanation of the study. Subsequently, the facilitator read and explained each question at a time, incorporating everyday examples to improve understanding. Participants were given approximately 2 minutes to respond before the facilitator moved to the next question.
Duration	~45 minutes
Questionnaire format	Paper

4.3.2.2. Teams description and maturity overview

In all, 45 respondents from 9 production teams participated in the maturity assessment. These teams belong to 3 different production units within the plant. However, 2 of them had only 2 respondents each, configuring insufficient data for a meaningful analysis. Consequently, the results of the maturity assessment are centered on the remaining 7 production teams, which are depicted in Table 4.5. Figure 4.8 presents their average maturity levels and total response dispersion.

Furthermore, Figure 4.9 illustrates the positioning of teams within the maturity model for company E2. It shows the teams' average maturity levels across the 5 dimensions of the model. Using dimensions rather than individual elements provides a more concise and clearer overview of each team's relative standing within the model.

Table 4.5 : Production teams with a significant number of respondents in Company E2.

Production unit	Teams	Number of respondents
Unit 1	E2_1	4 team members
Unit 2	E2_2	4 team members
	E2_3	5 team members
	E2_4	5 team members
Unit 3	E2_5	8 team members
	E2_6	9 team members
	E2_7	6 team members

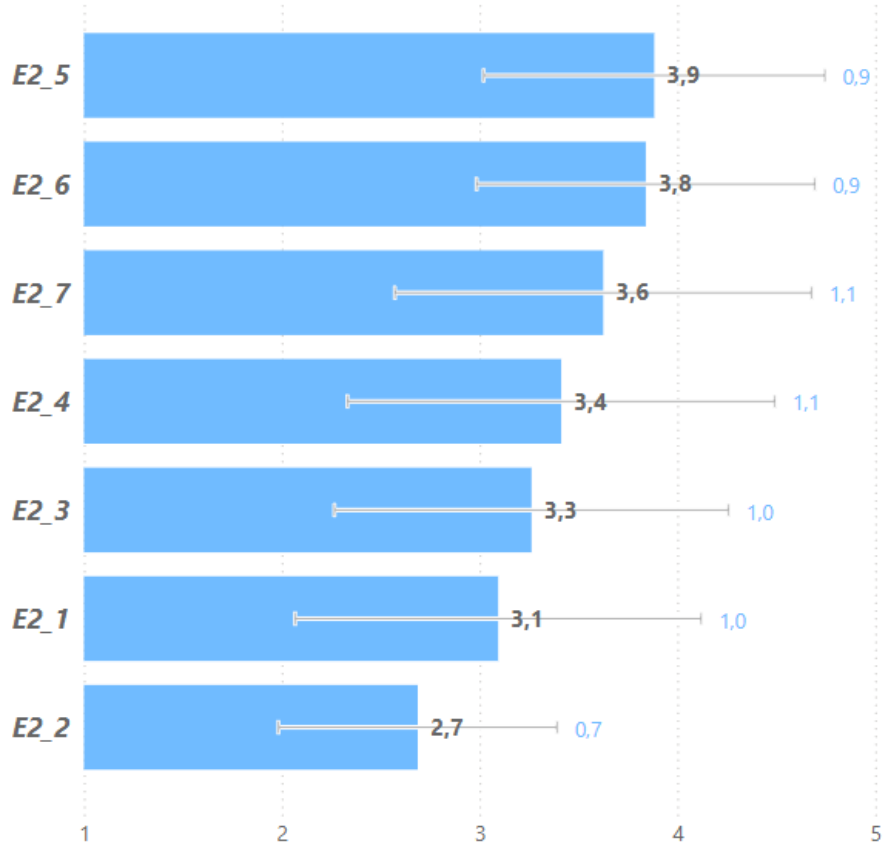

Figure 4.8 : Maturity levels and response dispersion of production teams (company E2).

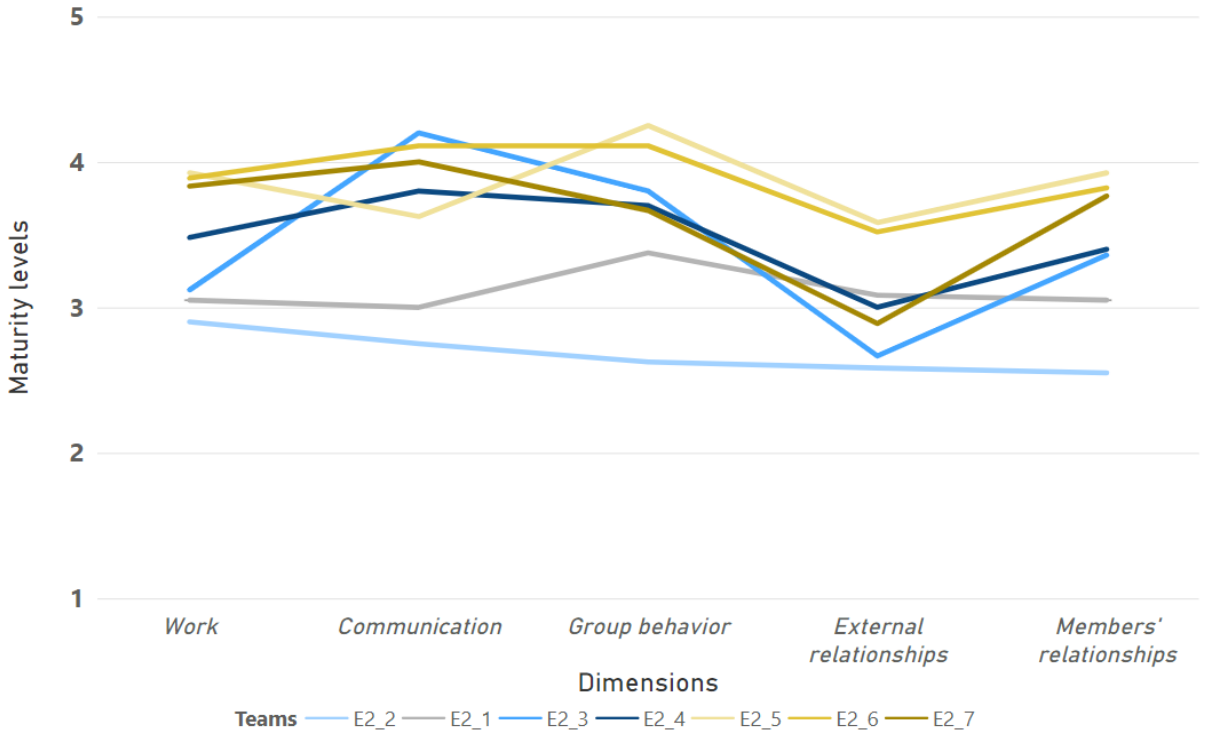

Figure 4.9 : Teams' maturity levels according to the 5 dimensions of the maturity model (company E2)

4.4. Cross-case analysis

4.4.1. Assessment protocols, general results and feedback from the case companies

This section delves into the different contexts in which the maturity study was conducted, along with the protocols adopted by each company, general results of team maturity, and feedback from the case companies.

Assessment protocols:

Both companies appropriated the team maturity assessment and conducted it independently, leading to variations in their assessment process that can be explored.

Table 4.6 outlines key contextual differences between the 2 case studies, providing insight that may clarify the assessment outcomes further analyzed in this section.

The overall assessment process was perceived as relatively straightforward in both companies, with a reasonable duration. In both cases, the facilitators committed to providing feedback on the results to the teams, but did not commit to any further actions afterward.

Table 4.6 : Major differences in assessment context and protocol in the 2 case studies.

Aspects	Company E1	Company E2
Assessment context: CI program and production teams	CI initiatives are mostly led by the Methods support team, with limited implication of production teams	Production teams are implicated in CI initiatives, and frequently receive CI related trainings
Communication strategy for the assessment process	Each plant handled the communication internally, presenting the maturity assessment as a broad study encompassing all teams (production and support)	The diffusion of the maturity assessment started with direct managers to the teams and progressively included the targeted production teams, ensuring everyone was on board
Assessment facilitation	Introduction to the team maturity study and general explanation of the assessment questionnaire	Respondents were guided through each question with contextual examples illustrating response options
Role of study facilitator	The facilitator oversees performance across all plants, resulting in limited contact with the production teams	The facilitators are based at the plant where the study was conducted and familiar with the production teams

General results:

Altogether, 85 respondents of 13 production teams across the 2 case studies provided the main dataset for the maturity assessments (Table 4.3 and Table 4.5). The overall average of all respondents' scores across the 6 production teams in company E1 and the 7 production teams in company E2 are depicted in Figure 4.10.

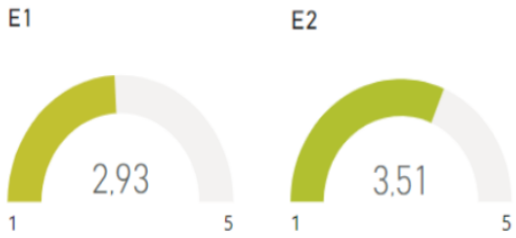

Figure 4.10 : Average of all respondents' maturity evaluations in the 2 companies.

In Company E2, production teams are actively involved in the CI initiative, receiving regular training and applying CI tools. In contrast, CI activities at Company E1 are primarily led by a dedicated support team.

Moreover, the teams in Company E2 displayed lower levels of response dispersion (Figure 4.6 and Figure 4.8), which may be linked to its customized assessment facilitation, which enhanced respondents' understanding of each response option. In contrast, Company E1 noted that the respondents carefully read each question, but struggled to maintain concentration throughout the assessment.

Against this background, the number of comments in the questionnaire section inviting suggestions for improving maturity elements was remarkably different between both companies. On average, participants from Company E1 approximately answered 4 open-ended questions, while those from Company E2 answered 1.

Feedback from facilitators:

The maturity assessment results (Figure 4.6 and Figure 4.8) aligned with both companies' perceptions of their teams' differing maturity levels, indicating a strong correspondence between the maturity assessment and observed reality. Company E1 expected the differences in the teams' maturity levels due to the varying advancements of CI initiatives in its 3 plants, while company E2 intentionally selected teams with contrasting perceived maturities to conduct the assessment.

Both companies endorsed the maturity study, considering the assessment results to be a valuable source of insight into their teams. Company E2, in particular, noted that the team maturity assessment approach complemented other existing CI practices within the organization.

The case companies conveyed the same sentiment in different terms: that an objective approach to measuring the maturity of production teams, rather than relying on perceptions, was beneficial to CI management.

In this sense, neither one seemed to express any concern about the subjectivity inherent in a self-evaluation questionnaire, thus reflected in the maturity measures. Company E2 provided detailed feedback on whether the highest and lowest maturity elements across teams were surprising or not, and indicated that the elements with lower-than-expected averages prompted reflection and encouraged a deeper investigation into the topic.

Furthermore, the evaluation of the open-ended questions by both companies was that the comments primarily reflected current situations. Company E1 specifically noted that the teams did not possess the maturity necessary to offer meaningful maturity improvement suggestions. Ultimately, neither company stated that the comments were relevant, nor did they affirm otherwise.

Company E1 believes that participants simply followed instructions to complete the assessment questionnaire without questioning it, lacking clarity on its purpose or the concept of team maturity. In different ways, both companies addressed a common concern: the respondents' level of understanding of CI concepts. In particular, Company E2 found the maturity levels of *Participatory problem-solving* across teams to be surprisingly low, prompting reflections on whether the teams were unaware that they were using CI tools learned in training to solve problems.

The Assessment reports were well received by both companies for their depth of content and thorough analysis. The section featuring the radar chart was especially appreciated by both organizations. Additionally, highlighting the varying maturity levels across teams enables internal benchmarking, a crucial step in developing an effective improvement plan. At last, Company E1 expressed that they are not yet sure how to manage the amount of information in the report, while Company E2 is interested in better understanding how to replicate the contextual factors that they believe contributed to the higher maturity level of some teams.

4.4.2. Insights on maturity elements

Maturity levels and response dispersion of maturity elements across teams:

The dataset comprising team maturity evaluations from 85 respondents across 13 production teams, representing 2 different companies and four production plants, can offer some general insights into maturity elements.

Therefore, Figure 4.12 presents a comprehensive overview of the maturity levels for each element across all teams, indicating which elements are consistently stronger or weaker. This analysis highlights maturity elements that may require further attention and helps identify broader maturity trends.

In the same vein, Figure 4.13 presents an overview of the dispersion for each maturity element across all teams, revealing areas where perceptions diverge significantly. This examination can help pinpoint

elements that may be unclear in the questionnaire and require clarification, as well as those likely to evoke disagreement or controversy.

To highlight the differences in maturity levels of elements and the differences in response dispersion of maturity elements across teams, conditional formatting with color gradients was applied. Given the large number of cells, the intention is to provide a high-level overview. The color-coding system in both figures is as follows:

Color scheme in Figure 4.12:

- Elements with higher maturity levels are shown in shades of green.
- Elements with lower maturity levels are shown in shades of red.

The intensity of the color reflects the level of maturity; the darker the green, the higher the maturity level, and the darker the red, the lower the maturity level.

Color scheme in Figure 4.13:

- Elements with lower dispersion are shown in shades of green.
- Elements with higher dispersion are shown in shades of red.

The intensity of the color reflects the level of dispersion; the darker the green, the lower the dispersion, and the darker the red, the higher the dispersion.

Concerning the color schemes in Figure 4.12 and Figure 4.13, simply put, shades of green represent better situations, while shades of red indicate the opposite. Furthermore, the maturity elements are presented in columns and organized by dimensions in both figures. The columns containing elements discussed throughout this section are highlighted for easy identification. The type of highlighting used in Figure 4.12 is **bold** for the **highest-ranked maturity elements**, and underline for the lowest-ranked. In Figure 4.13, **bold** is used for maturity elements with **lowest response dispersion**, and underline is used for elements with highest response dispersion. Simply put, bold is used to represent better situations, and underline the opposite in both figures.

Examining the average maturity levels of elements reveals that *Roles organization in the team*, *Autonomy level*, *Shared meaning*, and *Collaboration* are the highest-ranked, suggesting that production teams may find it easier to develop these aspects of maturity. *Roles organization in the team* is consistently well-rated by the teams, with the lowest maturity level being 3,1 in the E1_6 team, where this element ranks as the second strongest among all 16 maturity elements.

In contrast, *Communication with the program manager*, *Collaboration with other teams*, *Performance monitoring between members* and *Participatory problem-solving* are the lowest-ranked.

Performance monitoring between members also exhibits the highest response dispersion across the teams, further indicating that respondents may have different understandings of the element. Moreover, some respondents shared comments in the open-ended question of this element, suggesting it might be

subject to misinterpretation. They noted: "It would be a very bad idea to put operators against each other" and "We are not here to outdo others". On a different note, other respondents, including one from the same team as those mentioned above, shared constructive suggestions for improving the element.

From this angle, *Performance monitoring between members* requires a clearer explanation for the respondents of the assessment questionnaire, as well as for production teams in general, regarding its implications within CI initiatives, emphasizing that it is not designed to set teams or workers against each other. Members of effective CI production teams utilize tools such as visual management, performance dashboards, and daily start-up meetings to facilitate performance monitoring, enabling them to learn and drive continuous improvement within their teams (Van Dun & Wilderom, 2017).

The other maturity elements with the highest response dispersion across the teams are *Collaboration with other teams*, *Collaboration*, and *Communication openness*. This variation suggests that team members have differing experiences or interpretations of these aspects.

In contrast, the elements with the lowest dispersion - *Autonomy level*, *Performance level*, *Shared meaning*, and *Roles organization in the team* - indicate a more consistent understanding and rating among team members. Among these elements, 3 out of 4 are in the Work dimension.

Furthermore, some of the maturity elements discussed above are simultaneously among the highest-ranked levels and present the lowest response dispersion, and vice versa. Additionally, *Collaboration* stands out as it is both among the highest in response dispersion and the highest in maturity level. Figure 4.11 illustrates elements and their situations.

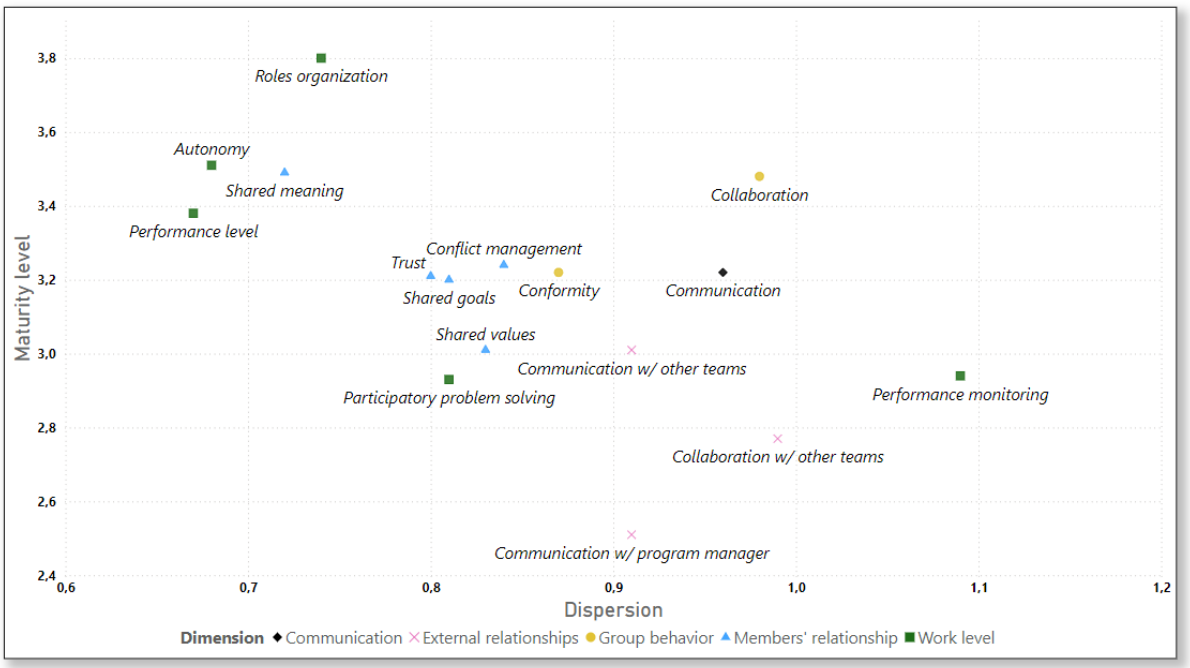

Figure 4.11 : Dispersion and maturity levels of elements.

The highest-ranked elements that also exhibited the lowest response dispersion are: *Roles Organization in the team*, *Autonomy level* and *Shared meaning*. One possible interpretation is that aspects more developed within the team are easier to evaluate, as they are likely topics that the team reflects on more thoroughly or even discusses collectively.

In general, the elements within the External Relationships dimension exhibit significant response dispersion. Concerning *Communication and Collaboration with other teams and departments*, respondents' interpretations may vary depending on the other teams and departments they associate with these elements. To ensure an accurate assessment, further clarification is needed to specify the relevant teams and departments, as these may differ from one organizational context to another. Likewise, for *Communication with the program manager,* it is important to clearly define who this individual, or individuals, are.

Overall, the analysis of maturity results across teams highlighted maturity elements that were often under-evaluated, such as *Participatory problem-solving* and *Performance monitoring among team members*. These 2 elements are particularly critical to CI initiatives, with the latter being context-specific and not identified in the maturity characteristics of all group types from the IMGD (section 2.5). As such, these elements require greater attention. Strategies to address this could include training programs to enhance collaborative problem identification and resolution, the use of visual tools such as dashboards for performance monitoring, and initiatives to foster collective responsibility for performance metrics.

Exploring maturity relationships through correlations:

Without aiming to generalize any of these findings, performing a correlation analysis of the complete dataset can provide additional insights into the relationships between the maturity elements. Thereby, the 85 maturity evaluations were analyzed using SPSS Statistics and the Spearman correlation coefficient, which is appropriate for non-normally distributed data.

The complete set of correlation results is provided in Appendix 3: Correlation analysis, while Table 4.7 highlights the highest correlations found between the maturity elements. Overall, the correlation results revealed 2 reassuring findings:

- No negative correlations ($-1<rho<0$): since all 16 maturity elements are designed to measure aspects of team maturity, their correlations should be positive ($0<rho<1$). This indicates that all elements move in the same direction, with no opposing patterns observed between them.
- No "very strong" correlations ($.8<rho<1$): very high correlations between 2 elements could indicate redundancy, raising questions about the need to distinguish them as separate elements.

Table 4.7 : Strongest correlations between maturity elements.

Correlation	**Spearman coefficient**	**Maturity elements**
Strong	.681	*Trust* and *Shared values*
Strong	.656	*Shared goals* and *Shared values*
Strong	.639	*Collaboration* and *Trust*
Strong	.604	*Participatory problem-solving* and *Shared values*
Moderate	.600	*Performance level* and *Shared goals*

The maturity element *Shared values* is involved in 3 of the 5 strongest correlations between the maturity elements. A strong relationship with *Trust* appears natural, as trust is more easily built when people share the same values. Similarly, the strong correlation between *Trust* and *Collaboration* is logical, as people are more likely to collaborate with those they trust. However, the strong correlation of *Shared values* with *Shared goals* can be better explained by the fact that these 2 elements are placed consecutively in the maturity questionnaire. Therefore, it is possible that the sequence of maturity questions in the assessment questionnaire - *Shared goals*, *Shared values* and *Shared meaning* - is tricky for respondents, and they may find it difficult to differentiate between these closely related concepts.

	Group behavior		Communication	Members' relationship					Work					External relationships			
Team	**Collaboration**	Conformity	Communication openness	Trust	Shared goals	Shared values	**Shared meaning**	Conflict management	Participatory problem solving	**Roles organization in the team**	Performance monitoring between members	**Autonomy level**	Performance level	Communication with the program manager	Communication with other teams	Collaboration with other teams	Average
E1_1	2,6	2,6	2,5	2,5	2,9	2,1	2,9	2,6	2,8	3,4	1,9	3,4	3,4	2,1	2,6	1,7	2,6
E1_2	4,1	3,5	4,5	4,0	3,0	2,9	3,3	4,0	2,7	3,6	2,4	3,8	3,8	1,7	2,7	1,7	3,2
E1_3	3,3	2,7	3,6	3,7	2,6	2,9	3,7	4,0	3,7	4,0	1,9	3,7	2,9	1,9	3,4	2,6	3,2
E1_4	4,0	3,5	3,1	3,9	3,6	4,0	3,6	4,2	3,7	3,9	3,7	3,9	4,1	3,2	3,4	3,6	3,7
E1_5	2,5	3,0	2,9	2,4	2,5	2,4	2,9	2,7	2,2	3,7	2,3	3,2	3,1	2,0	2,3	2,3	2,7
E1_6	2,1	2,2	2,3	2,1	1,9	1,9	2,9	2,4	2,0	3,1	2,2	3,3	2,4	2,0	2,4	2,0	2,3
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E2_6	4,11	4,1	4,0	3,8	4,0	3,8	3,9	3,7	3,6	4,2	3,4	4,2	4,0	3,7	3,4	3,4	3,8
E2_7	3,7	3,7	4,0	3,3	4,0	3,5	3,7	4,3	3,5	4,5	3,3	4,3	3,5	1,5	3,5	3,7	3,6
Average	**3,5**	**3,2**	**3,2**	**3,2**	**3,2**	**3,0**	**3,5**	**3,2**	**2,9**	**3,8**	**2,9**	**3,5**	**3,4**	**2,5**	**3,0**	**2,8**	**3,2**

Figure 4.12 : Averages of maturity elements across all participant teams.

	Group behavior		Communication	Members' relationship					Work					External relationships			
Team	Collaboration	Conformity	Communication openness	Trust	Shared goals	Shared values	**Shared meaning**	Conflict management	Participatory problem solving	**Roles organization in the team**	Performance monitoring between members	**Autonomy level**	**Performance level**	Communication with the program manager	Communication with other teams	Collaboration with other teams	Average
E1_1	0,86	1,05	1,34	1,28	0,64	0,86	1,15	1,29	0,92	1,40	0,83	0,95	0,90	0,99	0,90	1,03	1,03
E1_2	1,15	1,26	0,89	1,07	1,53	1,36	1,37	0,93	1,39	0,73	1,50	0,69	0,69	1,39	1,03	0,88	1,11
E1_3	1,16	0,70	1,22	0,70	1,18	0,99	0,45	0,76	0,45	0,53	1,12	0,45	0,64	0,83	1,05	1,40	0,85
E1_4	0,93	1,44	0,94	0,78	1,05	0,89	0,44	0,84	0,88	0,58	1,16	0,56	0,64	1,31	1,29	1,48	0,95
E1_5	1,20	1,05	1,10	0,83	0,94	0,96	0,74	0,82	0,92	0,82	0,67	0,92	0,68	0,67	0,71	1,25	0,89
E1_6	0,83	0,92	1,28	0,64	0,64	0,94	0,56	1,22	0,76	1,15	1,19	0,56	0,90	0,93	0,90	0,53	0,87
E2_1	1,5	1,09	0,71	0,83	1,09	0,71	1,09	0,71	0,83	0,5	0,87	0,83	0,83	0,83	0,83	0,83	0,88
E2_2	0,71	0,43	0,43	0,5	0	0,43	0,83	0,43	0,5	0,83	0,43	0,5	0,5	0,5	0,43	0,5	0,50
E2_3	0,49	0,75	0,75	0,8	0,63	0,8	0,49	0,49	1,2	0,49	1,33	0,49	0,75	0,98	0,8	1,47	0,79
E2_4	1,17	0,49	1,47	0,75	0,8	0,8	0,75	1,2	0,98	0,8	1,47	0,8	0,8	0,98	1,1	0,98	0,96
E2_5	0,83	0,66	0,7	0,5	0,48	0,48	0,33	0,71	0,43	0,5	1,22	0,87	0	0,97	0,86	0,7	0,64
E2_6	0,99	0,74	0,87	0,79	0,67	0,63	0,74	0,82	0,83	0,79	1,07	0,42	0,82	0,67	0,83	1,07	0,80
E2_7	0,94	0,75	0,82	0,94	0,82	0,96	0,47	0,75	0,5	0,5	1,37	0,75	0,5	0,76	1,12	0,75	0,79
Average	**0,98**	**0,87**	**0,96**	**0,80**	**0,81**	**0,83**	**0,72**	**0,84**	**0,81**	**0,74**	**1,09**	**0,68**	**0,67**	**0,91**	**0,91**	**0,99**	**0,85**

Figure 4.13 : Dispersions in evaluations of maturity elements across all participant teams.

4.4.3. Insights from respondents on improving maturity of elements

The 16 open-ended questions in the questionnaire, which invited suggestions for improving each maturity element, received a significant number of responses. Across 13 teams, the 85 respondents collectively provided 208 answers to these questions.

The maturity elements with the highest number of responses were *Communication openness* and *Collaboration*, with 23 and 19 suggestions, respectively. These are also the first and second elements listed in the questionnaire, suggesting that their higher response rate in comparison to the others may be linked to their placement. Conversely, *Trust* (third maturity question), *Shared values* (sixth maturity question), *and Collaboration with other teams* (sixteenth maturity question) received the fewest number of suggestions.

Although some suggestions focused on expressing views about current situations, some others were considered insightful, offering perspectives on how teams believe maturity elements can be developed.

In this context, Appendix 4: Suggestions of respondents to improve maturity of elements provides a table showing the number of responses along with 3 examples of respondents' suggestions for all maturity elements, while Table 4.8 highlights these same number of suggestions for 4 specific maturity elements.

Table 4.8 : Examples of suggestions from respondents to improve maturity elements.

Maturity element	Suggestion 1	Suggestion 2	Suggestion 3
Collaboration	“The recognition of this spontaneous collaboration”	“To collaborate even when everything is going well”	“To be more attentive and maintain the willingness to collaborate, even when the atmosphere is not favorable”
Trust	“More training and qualifications (they exist, but are consistently delayed, so no one gets qualified)”	“Fostering a good atmosphere within the team to build trust”	“Strengthen the bonds between operators through social moments and opportunities for sharing”
Participatory problem solving	“Sharing the problems encountered and the solutions implemented”	“The team is not necessarily familiar with the machines”	“Our hierarchy prevents us from solving problems on our own”
Performance monitoring between members	“Production display from the day before”	“Computer tool”	"To have overall recognition of the team"

These examples of respondents' suggestions highlight some important internal perspectives from the team. On one hand, some suggestions are very practical, such as the need for training to increase trust among team members or the implementation of tools to monitor performance. On the other hand, some responses reflect deeper thoughts about aspects that need to be worked on within the team, such as collaborating even when things are going well. Additionally, these examples underscore that internal efforts should not be carried out in isolation, but require recognition and support from management, for example through the acknowledgment of spontaneous collaboration.

Overall, the optional open-ended questions received more responses than expected, indicating that respondents appreciated having a platform to share their views. However, the volume of suggestions can be overwhelming and difficult to analyze.

4.4.4. Toward an optimal protocol for team maturity assessment

The 2 case studies, along with their distinct approaches to conducting the maturity assessment, provide important lessons toward an optimal protocol for future research and practical applications. These findings contribute to refining the assessment process, enhancing both the accuracy of results and the effectiveness of the approach.

Despite participating in a CI initiative, respondents may not fully grasp many related concepts or methods. Therefore, to enhance respondents' understanding of the approach and the accuracy of their evaluations, the assessment process should include an explanation of CI principles prior to administering the questionnaire, extending beyond a simple introduction to the study and its objectives.

The evaluations of both assessments, alongside a dispersion analysis, indicate that the assessment process performed in case E2 (Table 4.6) improves the accuracy of results. A comparison of the total dispersion of teams in E1 (Figure 4.6) and E2 (Figure 4.8) reveals that teams in E2 exhibit slightly lower dispersion. This total dispersion is calculated by comparing each individual response to the overall mean of all answers, or the overall team maturity level. A more focused analysis of the dispersion of responses for each individual maturity element (Figure 4.13) provides further insight. When comparing the average dispersion of each maturity element across all 13 teams, it becomes clear that teams in E2 show lower dispersion. For example, this can be further illustrated by comparing the dispersions of teams with similar maturity levels and number of respondents.

Table 4.9 presents this comparison, highlighting the differences in dispersion across these teams.

Table 4.9 : Dispersion across teams with similar profile.

Team	Respondents	Maturity level	Total dispersion	Dispersion per element
E1_2	7	3,22	1,41	1,11
E1_3	7	3,16	1,13	0,85
E2_3	5	3,26	1,00	0,79

Therefore, the facilitation and support of Company E2 (Table 4.4) can help prevent misinterpretations of the questionnaire's content. This approach includes guiding respondents through each option, allowing sufficient time for responses before proceeding, and offering context-specific examples to foster a shared understanding of the questions and options.

Moreover, since the questionnaire is relatively long, this navigation approach also prevents respondents from becoming fatigued and distracted. While the 45-minute duration of the assessment in E2 exceeds the initial 30-minute estimate from the design phase, it is ultimately more engaging and less tiring.

Furthermore, given that the questionnaire directly asks employees to self-evaluate various aspects of their teams' work, including performance, it is important to introduce it gradually, giving everyone time to understand its purpose and get on board before administering the questionnaire. Without this, the assessment may be perceived as just a monitoring tool, preventing it from becoming an opportunity for reflection and hindering honest responses.

The communication around the team maturity assessment should be clear and transparent to ensure it is well-received. Besides, an open communication between management and production teams is essential to team maturity.

Building on the discussions above, a formal protocol for applying the team maturity assessment is established and presented in Table 4.10. The objective is to offer structured, clear information to guide an effective and optimal implementation of the maturity assessment approach.

Table 4.10 : An improved protocol for team maturity assessment.

Protocol	**Guidelines**
Assessment management	- CI managers should take ownership of the team maturity assessment, which requires a thorough understanding of the questionnaire's content and assessment objectives. - The facilitator can be external or have limited interaction with the teams, as long as the CI managers directly involved with the teams fully embrace the overall maturity assessment. - The communication strategy should be clear, engaging all parties gradually and encouraging full participation.
Assessment process	- Teams should be gathered in a designated room suited for the assessment. - The facilitator should guide respondents through each section of the questionnaire, ensuring that they fully understand the questions and options and allowing sufficient time for responses before moving on. Context-specific examples can be provided to help respondents easily relate to the questions. - Generally, 45 minutes are sufficient to apply the questionnaire.

4.5. Conclusions of the team maturity assessment

This chapter extends the theoretical foundation established in previous chapters by testing the viability of the team maturity approach in real-world CI contexts. Its main objective was to evaluate the feasibility of the proposed team maturity assessment, providing practical evidence that refines the approach and explores its potential to engage teams in a CI dynamic and support CI initiatives.

An assessment questionnaire was developed to capture team members' self-evaluations of team maturity. The results of the team maturity assessment aligned with the companies' perceptions of the teams' maturity levels, supporting their consistency and the effectiveness of the assessment tool. In fact, the case studies confirmed the feasibility of the questionnaire with production teams. Additionally, allowing companies to manage the assessments themselves helped to define an optimal protocol.

Altogether, the assessment requires minimal resources, mainly the facilitators' time to familiarize themselves with the questionnaire and the time needed from teams to complete it. However, when scaled to multiple teams, the format becomes crucial. Paper-based surveys can significantly increase data processing time, reducing practicality. Transitioning to a digital format would address this issue.

Moreover, the assessment results provided insights into elements that may require revision in the assessment questionnaire. Specifically, items with high response dispersion, such as *Performance monitoring between members*, *Collaboration with other teams*, *Collaboration*, and *Communication openness*. Additionally, elements within the External relationships dimension, as well as the elements *Shared values*, *Shared goals*, and *Shared meaning*, may also cause confusion for respondents and should be clarified.

Responses to the open-ended question on improving maturity suggest that the assessment effectively prompted team members to reflect on enhancing maturity, either through internal efforts or company-led actions. This underscores the potential of the approach to engage teams in a maturity journey, contingent on companies' active commitment. The higher maturity levels observed in the case with the more advanced CI program further reinforced this link, suggesting that mature programs positively influence team maturity, in line with the construct’s fit to the CI context. However, the case studies also revealed that teams within the same production site and CI program exhibited significantly different maturity levels, also noted by managers in daily operations. This indicates that maturity is a much more intricate concept, shaped by a variety of internal and external factors.

At last, the CTMIP outlines a team maturity approach designed to engage teams into a CI dynamic through an assessment and improvement loop. Based on the assessment results and the teams' positioning within the team maturity model, specific maturity elements can be targeted for improvement. A timeline can then be set, followed by reassessment to evaluate the actual impact of the actions taken on these elements and the potential of the approach to effectively support CI initiatives.

General conclusion and perspectives

The enduring challenges in sustaining CI programs, often linked to the human aspect of initiatives, do not reflect an absence of human potential within these programs; instead, they expose the lack of favorable conditions for human engagement to develop, which, in turn, hinders the very progress organizations strive to achieve.

This thesis sought to contribute to progress dynamics within organizations in the context of CI, where the workforce is the primary driver of improvement. With the overarching goal of exploring effective ways to engage teams in a CI dynamic to support initiatives, this study proposed a human-centered and practical approach based on team maturity.

The research was structured into 4 chapters, with their key content and contributions outlined in the following paragraphs.

The first chapter focused on refining the research context to identify gaps and delineate the approach. An in-depth investigation of relevant literature led to the definition of the team maturity approach and further objectives to explore, such as the maturity characteristics of production teams in CI contexts, how to effectively assess the maturity of these teams, and how organizations can be better supported in developing tailored maturity improvement plans.

Some key points explored throughout the chapter included:

- The limited research on the workforce in CI, particularly concerning factors beyond technical skills, and the absence of assessments that capture their dynamics or considers a more comprehensive viewpoint, not restricted to usual performance indicators.
- The specific dynamics of CI programs that require workers to uphold specific behaviors and values to support initiatives. The mutual influence between workforce and management in these settings, and the role of teams in fostering members' participation in CI, minimizing negative effects of CI contexts, and enhancing satisfaction and well-being.
- The overarching notion of maturity, which is not limited to actions, and also implies mutual influences between individuals, groups, and their environment. Maturity also conveys a state of full development, which inspired the creation of maturity models to assess processes. However, maturity models are mostly designed for managerial use only, and no models were found reflecting production teams' dynamics or capturing their direct perspectives.

The second chapter addressed team maturity identification through the consolidation of 3 distinct sources: a SLR on group development, a SLR focused on CI production teams, and CI experts. The result was a team maturity characterization consisting of 5 dimensions structuring 16 maturity elements.

This methodology led to the following theoretical contributions:

- The structuring of the Integrated Model of Group Development (IMGD) into 4 identified dimensions through which groups evolve.
- The association of 2 literature disciplines, group development and CI, introducing a new developmental perspective for production teams within the CI domain.
- A comprehensive and highly adapted team maturity characterization, achieved by first expanding the scope to encompass various group types before narrowing the focus to CI production teams.

From a more practical standpoint, contributions involved:

- A construct closely aligned with real-world conditions and grounded in empirical evidence, achieved through the exclusive use of empirical studies from both literature sources, along with expert opinion.
- A practical and easily understandable construct, drawing from an extensive theoretical foundation, while presenting maturity elements that are straightforward for CI practitioners to grasp.
- A construct that facilitates the further development of practical assessments and improvement actions, allowing for an individual focus on specific maturity elements.

The third chapter delved into the assessment and improvement process of team maturity, introducing the Conceptual Team Maturity Improvement Process (CTMIP). This structure organized theoretical insights for practical application, ultimately aiming to engage production teams into a CI cycle.

Through this conceptual process, the relevant dynamics of production teams were identified through a maturity characterization. Based on the teams' maturity level and assessment, tailored improvement actions focus on addressing the contextual factors that influence team maturity, potentially integrating teams into an assessment and improvement loop.

To assess team maturity, a team maturity model was developed and established 5 maturity levels for the 16 maturity elements structured in 5 dimensions of the characterization. A self-assessment approach was determined to capture members' direct evaluations of team maturity. The strength of this individualized, human-centered approach lies in engaging each team member in the team maturity assessment, ensuring that their perspectives are directly captured. This emphasis on their individual input addresses a common gap by balancing the typically prioritized perspectives of managers with the often-overlooked viewpoints of workers. Additionally, including a question that prompts team members to suggest improvements for maturity elements further encourages reflection and increases their involvement in the process.

To assist with team maturity improvement at the organizational level, contextual factors that impact team maturity were identified from the same literature sources used to characterize it, leading to the mapping of 3 axes of intervention and 11 team maturity influencers that can guide organizations in the development of customized improvement plans.

Altogether, theoretical and practical contributions encompassed:

- An innovative team maturity model, grounded in a robust theoretical foundation and reinforced by empirical evidence, including external validation.
- A self-assessment approach that directly captures members' evaluations of team maturity, prompting each member to evaluate maturity elements within their teams.
- The mapping of 3 axes of intervention and 11 team maturity influencers, integrated within the CTMIP alongside the maturity assessment, to guide targeted actions for improvement.
- The creation of 20 illustrative improvement actions intended to assist organizations in developing their own tailored improvement plans.

The fourth chapter presented a case study methodology to test the maturity assessment approach in real-world settings. A questionnaire, based on the team maturity model and assessment approach, was developed and administered to 85 respondents from 13 production teams across 2 case companies. The case studies confirmed the feasibility of the maturity assessment, and suggested the potential of the approach to support CI initiatives.

The maturity questionnaire consisted of 16 questions, each aligned with a specific maturity element. Each question provided five response options, reflecting different maturity levels, with descriptions of team dynamics at each level to guide respondents in evaluating their position. Additionally, an assessment report was prepared for each company, summarizing the maturity assessment results.

The main results of the case studies provided the following contributions:

- The alignment of maturity results with managers' daily perceptions of teams' maturity indicated that the overall team maturity construct reflects a real and relevant concept.
- The self-assessment questionnaire is both feasible and effective in capturing the maturity of production teams, offering a reliable measure of team maturity based on a reference model.
- An optimal maturity assessment protocol that enhances quality of results by minimizing misinterpretations and enabling companies to provide contextually relevant information that resonates with the teams being assessed.
- Maturity elements and/or questions that may currently cause confusion for respondents and should be revisited or clarified in the assessment questionnaire.

In fact, a structured method to assess team maturity can serve as a practical tool to support CI programs and, ultimately, engage production teams into the CI dynamic.

A human-centered, maturity-based approach brings a perspective often absent from traditional CI initiatives. It highlights critical team aspects beyond standard performance metrics, such as *Collaboration* and *Shared goals*, which conventional methods frequently overlook. Neglecting these aspects limits immediate performance and hinders the potential for sustainable progress through meaningful human engagement.

Overall, team maturity represents a more comprehensive view of the teams and their dynamics, within an environment, and influenced by various contextual factors. This approach not only aligns more closely with reality, but also provides a clearer understanding of teams' actual outcomes and, consequently, the results of CI initiatives. By recognizing these key aspects, organizations can address them effectively and work alongside teams to strengthen team maturity.

Limitations:

While this research provided valuable theoretical and practical contributions, certain limitations must be acknowledged. Recognizing these is essential for refining the approach in the future.

The team maturity construct

The team maturity characterization is subject to several limitations. While based on a solid theoretical foundation consolidating distinct sources for comprehensiveness and adaptability to the CI context, the maturity elements may not fully represent all teams in CI program contexts. Certain aspects of maturity relevant to specific situations may have been overlooked. In fact, adapting the construct to a context as broad as CI initiatives makes achieving a universally perfect characterization impractical. However, a methodological limitation can be the lack of direct input from production teams during this phase of the research (e.g. through observations, focus groups, preliminary surveys).

The team maturity model and the CTMIP

The definition of five maturity levels in the team maturity model represents a practical choice for reference, while the assessment approach - calculating overall maturity as the average of all elements - risks oversimplifying contexts where certain elements may carry more weight than others. Furthermore, maturity elements are interconnected and inherently complex, and the model does not provide explicit guidance on how teams should progress from one level to the next. Instead, it is embedded within the CTMIP, which focuses on fostering overall enhancement and engagement through improvement actions that have broader impacts beyond a single maturity element.

This approach recognizes the difficulty of ensuring that specific actions consistently achieve the desired maturity outcomes. To address this, it incorporates a map of axes of intervention and team maturity influencers, aimed at supporting the development of tailored actions to meet the unique needs of each context.

The assessment questionnaire

Even though the self-assessment approach directly captures team members' evaluations of maturity - a key strength of the proposal - the limitations of the maturity construct and model inevitably impact the quality of the assessment. Maturity elements that may not align with specific organizational contexts or team dynamics can lead to confusion among respondents. Similarly, the response options, while intended to guide teams in their evaluations, may not adequately reflect the respondents' specific contexts, potentially leading to confusion. In this sense, the maturity assessment results offer valuable

insights by identifying problematic questions for respondents, serving as a basis for future clarification and refinement of these elements within the approach.

Case studies

The study with 2 case companies and 4 production sites in France highlights that this research is still in its early stages. While the sample of 85 respondents across 13 production teams is significant, it must be acknowledged that these are initial steps, and further case studies involving teams in varied contexts are essential to refine the elements, questionnaire, and protocol. In addition, time constraints limited the scope of the study, and prevented the test of an important aspect: the implementation of improvement actions and subsequent reassessments to measure their impact on maturity. It is also important to emphasize that achieving measurable results following the implementation of actions can require several months, further underscoring the need for extended research timelines.

Perspectives:

Despite the challenges of studying the human aspect of CI, focusing on team maturity as a means to support these initiatives shows promise. This research began with a bibliographic study in an underexplored field, leading to the development of a conceptual model. Building on this foundation, fieldwork was conducted to validate and refine the team maturity approach, bridging theory with practical insights. While these contributions mark a significant step forward, they also highlight the emergent nature of this work.

There is potential to further refine the theoretical foundations of the team maturity construct. Future studies could extend the exploration of team maturity to domains not yet examined, uncovering new contexts and applications. In this sense, involving a more diverse range of CI experts and directly engaging production teams in subsequent research could further enrich the maturity construct. This approach may contribute to achieving a better balance between the precision of maturity elements and the practicality of the overall construct. Additionally, analyzing the maturity dimensions independently could help to determine whether they can serve other purposes beyond their current role of structuring maturity elements. For example, these dimensions could be leveraged for broader, more general assessments.

Moreover, the research could benefit from exploring the connections between individual maturity and team maturity. Future efforts could focus on identifying the specific characteristics of individual maturity that contribute to team maturity. By exploring these links, researchers could gain a deeper understanding of how individual attributes influence team dynamics and collective performance. This line of inquiry could also support a more precise integration of individual maturity into the CTMIP, fostering a more holistic understanding and approach of the human aspect within CI initiatives.

From a practical standpoint, significant advancements can still be achieved. Conducting new case studies across different organizational contexts can contribute to more compelling results about the generalizability of the team maturity approach. At the same time, these studies are essential for refining

the assessment questionnaire, improving the protocol, and generating deeper insights that could further develop both the maturity model and the underlying team maturity construct.

Many opportunities arise from this expansion, particularly in exploring new methods for gathering insights from case companies and directly from production teams. A well-structured methodology could be designed to complement the maturity assessment, aiming to capture more precise and reliable insights into the relevance of the maturity dimensions and each maturity element.

Future studies could include a more detailed investigation of teams' specific contexts. Additionally, comparing maturity results with existing organizational metrics related to teams in daily operations could help establish clearer links between measured maturity levels and actual team dynamics, further enriching the maturity model with evidence.

Moreover, expanding existing case studies into longitudinal studies is crucial for advancing the research, which seeks to contribute to the sustainability of CI programs. Monitoring teams over time and evaluating how action plans are implemented in practice is particularly significant, examining whether maturity results serve as effective guides, whether the proposed axes of intervention and maturity influencers provide meaningful support, and identifying the strategies companies adopt to enhance specific maturity elements. These studies could also provide insights into an ideal time interval between assessments, if such an interval exists. In general, it seems reasonable to state that reassessments should respect a minimum gap of 3 months, as maturity requires time to develop.

Longitudinal studies can truly assess the long-term impact of this approach in engaging teams and supporting CI initiatives. Notably, one of the companies analyzed in the case studies has expressed interest in continuing the work, particularly in developing an action plan to enhance team maturity, underscoring the practical relevance of this research and opening the way for the refinements and advancements discussed.

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Appendices

Appendices Overview

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Appendix 1: Assessment questionnaire





Étude de la maturité de l'équipe pour contribuer à la dynamique de progrès

Étude de Cas

Gabriella Gambarra Moreira
Magali Pralus
Julien Boissière
Georges Habchi











Étude de Cas et Questionnaire

Le laboratoire SYMME (Université Savoie Mont Blanc) mène une étude qui porte sur la maturité des talents lors des démarches de progrès en entreprise. Cette recherche est soutenue par le 3ème Programme d'investissements d'avenir.

Dans le cadre de cette recherche, nous menons une étude terrain auprès des membres actifs de l'amélioration continue. Cette étude est constituée de 16 questions relatives à la maturité des talents et des équipes. L'objectif est de confronter les résultats de recherche avec les réalités du terrain.

Ce questionnaire s'adresse aux talents des équipes amenées à mettre en place des actions de progrès. Il aborde le contexte et la dynamique du groupe.

Le temps de réponse estimé est d'une trentaine de minutes. Nous vous remercions vivement pour votre participation !

CONFIDENTIALITE DES DONNEES : Toutes les réponses seront traitées de façon anonyme. Les noms des sociétés participantes à cette recherche ne seront pas diffusés sans leur accord explicite.

SECTION 1 : **Identification de l'équipe** (*le répondant appartient à une équipe dont on a besoin de distinguer pour nos résultats de recherche)*

* Cette section doit être adaptée à chaque entreprise étudiée.

SECTION 2 : **Caractérisation du répondant**

Tranche d'âge : □ 18 à 25 ans □ 25 à 40 ans □ 40 à 55 ans □ + 55 ans

Ancienneté dans l'entreprise : □ Moins d'un an □ 1 à 3 ans □ 3 à 10 ans □ + 10 ans

Ancienneté dans votre équipe actuelle : □ Moins de 6 mois □ 6 mois à 1 an □ 1 à 3 ans □ + 3 ans

Depuis combien de temps participez-vous à l'amélioration continue (dans ou en dehors de votre équipe actuelle) ? □ Moins d'un an □ 1 à 3 ans □ 3 à 8 ans □ + de 8 ans

SECTION 3 : **Par rapport à votre équipe**

1) Quelle affirmation correspond le plus à la **communication au sein de l'équipe** ?
□ les membres de l'équipe ne communiquent pas.
□ les membres de l'équipe communiquent et partagent des informations selon leur volonté.
□ l'équipe a une tendance spontanée à communiquer et à partager des informations importantes en son sein.
□ l'équipe communique de façon systématique et partage des informations de tous types. De plus, il y a du feedback et de la reconnaissance des contributions de chacun.
□ la communication est naturelle, claire et ouverte au sein de l'équipe, y compris dans le partage d'informations, le feedback et la reconnaissance des contributions de chacun.

- D'après vous, quelles actions pourraient **renforcer la communication** au sein de l'équipe ?

2) Quelle affirmation correspond le plus à la **collaboration au sein de l'équipe** ?
□ il n'y a pas de collaboration/coopération entre les membres de l'équipe.
□ les membres de l'équipe collaborent éventuellement, selon leur volonté.
□ en cas de problème, l'équipe a une tendance spontanée à collaborer.
□ la collaboration dans l'équipe est systématique et n'est pas uniquement en réaction à un problème.
□ la collaboration est naturelle et fait partie de l'esprit de l'équipe. Il y a une cohésion, du respect et du soutien entre les membres de l'équipe.

- D'après vous, quelles actions pourraient **renforcer la collaboration** au sein de l'équipe ?

3) Quelle affirmation correspond le plus à la **confiance au sein de l'équipe** ?
□ les membres de l'équipe ne se font pas du tout confiance.
□ les membres de l'équipe se font confiance dans certaines situations spécifiques.
□ les membres de l'équipe ont tendance à se faire confiance et à avoir confiance en l'équipe, notamment dans des situations importantes.
□ l'équipe possède un niveau élevé de confiance (confiance entre les membres et confiance en l'équipe) quels que soient les types de situations.
□ l'équipe se fait totalement confiance et la confiance entre les membres est solide et immuable.

- D'après vous, quelles actions pourraient **renforcer la confiance** au sein de l'équipe ?

4) Quelle affirmation correspond le plus à la **conformité de l'équipe avec les politiques internes et les pratiques de l'entreprise** ?
□ les membres de l'équipe n'agissent pas en accord avec les politiques internes et les pratiques de l'entreprise et cela ajoute des tensions entre eux, souvent à l'origine de problèmes de comportement.
□ les membres de l'équipe ont du mal à accepter et agir conformément à certaines politiques internes et pratiques de l'entreprise, ce qui engendre quelques problèmes de comportement.
□ l'équipe est neutre par rapport à la politique interne et les pratiques de l'entreprise, ce sujet n'engendre pas de problème dans l'équipe, qui agit plutôt en conformité avec ces règles.
□ l'équipe agit en accord avec la politique interne et les pratiques de l'entreprise, et elle se comporte pleinement en conformité avec ces règles.
□ l'équipe est en parfaite harmonie avec la politique interne et les pratiques de l'entreprise, la conformité aux règles est naturelle.

- D'après vous, quelles actions pourraient **renforcer la conformité** au sein de l'équipe ?

5) Quelle affirmation correspond le plus au **partage d'objectifs au sein de l'équipe** ?
□ les membres de l'équipe ne partagent pas du tout les mêmes objectifs.
□ les membres de l'équipe ont quelques objectifs spécifiques en commun.
□ l'équipe partage les objectifs les plus importants, mais pas toujours leur priorisation.
□ l'équipe partage tous ses objectifs ainsi que leurs priorités. Elle partage également la même vision de sa stratégie.
□ l'équipe intègre pleinement et naturellement l'ensemble des objectifs, leurs priorités et sa stratégie.

- D'après vous, quelles actions pourraient **renforcer le partage d'objectifs** au sein de l'équipe ?

_____

_____

6) Quelle affirmation correspond le plus au **partage de valeurs au sein de l'équipe** ?
□ les membres de l'équipe ne partagent pas du tout les mêmes valeurs.
□ les membres de l'équipe ont quelques valeurs en commun.
□ l'équipe partage quelques valeurs qui ont un impact bénéfique sur son activité.
□ l'équipe partage des valeurs de dépassement de soi (exemples : bienveillance, tolérance, serviabilité, justice, etc.) et d'ouverture au changement (exemples : créativité, curiosité, etc.).
□ les valeurs de dépassement de soi et d'ouverture au changement font partie de l'esprit de l'équipe.

- D'après vous, quelles actions pourraient **renforcer le partage de valeurs** au sein de l'équipe ?

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7) Quelle affirmation correspond le plus au **partage de sens au sein de l'équipe** ?
□ les membres ne voient pas du tout d'intérêt à leur travail dans l'équipe.
□ les membres voient peu d'intérêt dans leur travail dans l'équipe.
□ l'équipe voit un intérêt ou un sens au travail de l'équipe, mais cela impacte peu son activité.
□ l'équipe voit un sens à son travail, et cela constitue une raison de bien faire les choses.
□ l'équipe voit et cultive un sens à son travail, qui comprend, entre autres, un sentiment d'appartenance.

- D'après vous, quelles actions pourraient **renforcer le partage de sens** au sein de l'équipe ?

8) Quelle affirmation correspond le plus à la **gestion du conflit au sein de l'équipe** ?
□ les membres de l'équipe n'arrivent pas à gérer leurs conflits et il y a beaucoup de tensions entre eux.
□ les membres de l'équipe gèrent partiellement leurs conflits, cela engendre quelques tensions au quotidien
□ l'équipe arrive à résoudre les conflits importants.
□ l'équipe résout toujours ses conflits même si cela prend du temps.
□ les conflits au sein de l'équipe sont rapidement résolus et cela renforce la confiance entre les membres.

- D'après vous, quelles actions pourraient **renforcer la gestion du conflit** au sein de l'équipe ?

9) Quelle affirmation correspond le plus à **l'organisation des rôles au sein de l'équipe** ?
□ la répartition des rôles entre les membres de l'équipe n'est pas du tout claire.
□ les membres de l'équipe connaissent mal leurs rôles.
□ l'équipe arrive à s'organiser chaque jour, même si la répartition des rôles n'est pas claire pour tout le monde.
□ l'équipe est organisée avec des rôles précis et bien répartis. Chaque membre connaît son rôle.
□ l'organisation claire et partagée des rôles au sein de l'équipe valorise son fonctionnement.

- D'après vous, quelles actions pourraient **renforcer l'organisation des rôles** au sein de l'équipe ?

10) Quelle affirmation correspond le plus au **niveau d'autonomie de l'équipe** ?
□ les membres de l'équipe ne sont pas autonomes et ont besoin d'être constamment aidés par les responsables.
□ les membres de l'équipe sont souvent aidés par les responsables.
□ l'équipe a besoin des instructions des responsables, mais dans la plupart des cas elle peut s'en sortir toute seule.
□ l'équipe est autonome et proactive dans la proposition d'actions.
□ l'équipe est autodirigée : elle propose et décide des actions qu'elle va mener.

- D'après vous, quelles actions pourraient **renforcer le niveau d'autonomie** au sein de l'équipe ?

11) Quelle affirmation correspond le plus à la **résolution de problèmes au sein de l'équipe** ?
□ les membres de l'équipe ne résolvent pas les problèmes ensemble.
□ les membres de l'équipe résolvent quelques problèmes spécifiques ensemble, mais de façon désorganisée.
□ l'équipe a tendance à résoudre les problèmes jugés importants ensemble.
□ l'équipe résout les problèmes de façon participative et méthodologique, et prend les décisions en commun, lorsque c'est nécessaire.
□ les processus de résolution de problèmes et de prise de décision sont partagés, clairs, méthodologiques et participatifs. Ils font partie de l'esprit de l'équipe.

- D'après vous, quelles actions pourraient **renforcer la résolution de problèmes** au sein de l'équipe ?

12) Quelle affirmation correspond le plus au **suivi des performances au sein de l'équipe** ?
□ il n'existe pas de suivi des performances entre les membres de l'équipe.
□ les membres de l'équipe n'ont pas de retour sur les performances de chacun. Ils savent à peine ce que font les autres.
□ l'équipe constate les performances des membres dans des situations importantes.
□ il y a un suivi des performances dans l'équipe, générant des actions de correction et/ou de délégation des tâches entre les membres.
□ le pilotage des performances est naturel et fait partie de l'esprit de l'équipe.

- D'après vous, quelles actions pourraient **renforcer le suivi des performances** au sein de l'équipe ?

13) Quelle affirmation correspond le plus au **niveau de performances de l'équipe** ?
□ les membres de l'équipe ont un mauvais niveau de performance.
□ les membres de l'équipe ont un niveau de performance correct et stable, mais avec peu de remise en question.
□ l'équipe a un bon niveau de performance et arrive à améliorer ses processus de temps en temps.
□ l'équipe est performante, flexible et améliore ses processus.
□ l'équipe possède un niveau élevé de performance, elle est flexible et améliore ses processus régulièrement.

- D'après vous, quelles actions pourraient **renforcer le niveau de performances** au sein de l'équipe ?

14) Quelle affirmation correspond le plus à la **communication de l'équipe avec le pilote des démarches de progrès ?**
□ il n'existe pas de communication entre les membres de l'équipe et le pilote des démarches de progrès.
□ les membres de l'équipe communiquent occasionnellement avec le pilote des démarches de progrès.
□ l'équipe communique sur les sujets importants avec le pilote des démarches de progrès.
□ l'équipe communique sur tous les aspects avec le pilote des démarches de progrès.
□ l'équipe est complètement ouverte et communique constamment et naturellement avec le pilote des démarches de progrès.

- D'après vous, quelles actions pourraient **renforcer la communication de l'équipe avec le pilote** des démarches de progrès ?

15) Quelle affirmation correspond le plus à la **communication de l'équipe avec d'autres équipes et départements/services** ?
□ il n'existe pas de communication entre les membres de l'équipe et d'autres équipes.
□ les membres de l'équipe communiquent de temps en temps avec d'autres équipes sur des sujets ponctuels.
□ l'équipe a tendance à communiquer avec d'autres équipes dès qu'il y a un problème.
□ l'équipe communique régulièrement avec d'autres équipes et partage des informations importantes.
□ l'équipe est naturellement ouverte à la communication et au partage avec d'autres équipes.

- D'après vous, quelles actions pourraient **renforcer la communication de l'équipe avec d'autres équipes et départements/services** ?

16) Quelle affirmation correspond le plus à la **collaboration de l'équipe avec d'autres équipes et départements/services** ?
□ il n'existe pas de collaboration avec d'autres équipes.
□ les membres de l'équipe collaborent avec d'autres équipes dans des situations spécifiques.
□ l'équipe collabore avec d'autres équipes si c'est bénéfique pour elle.
□ l'équipe a tendance à collaborer avec d'autres équipes dès qu'elle estime qu'il y a un minimum de bénéfice pour l'entreprise.
□ il existe un esprit de collaboration dans l'équipe qui s'implique naturellement pour le bénéfice de l'entreprise.

- D'après vous, quelles actions pourraient **renforcer la collaboration de l'équipe avec d'autres équipes et départements/services** ?

SECTION 4 : **Leviers de progrès**

Dans notre recherche, nous avons identifié des leviers de progrès pour les équipes, par exemple :

- **Formations :** formations techniques ou en relations humaines.

- **Structure du travail :** répartition des tâches en fonction des compétences, sécurité physique au travail, lieux de travail appropriés, nombre de membres dans l'équipe…

- **Disponibilité des ressources pour pratiquer l'amélioration continue :** accès aux outils d'amélioration continue, réunions d'équipe régulières, tableaux de pilotage…

- **Soutien du management :** présence active des pilotes sur le terrain, communication des valeurs et objectifs aux membres des équipes, responsabilisation des équipes, valorisation des équipes…

Avez-vous une autre idée d'action pour **renforcer les éléments de maturité** dans les équipes ?

_____

_____

Si oui, crochez les éléments de maturité qui seraient renforcés.		
☐Communication	☐Collaboration	☐Collaboration avec d'autres équipes
☐Confiance	☐Conformité	☐Communication avec d'autres équipes
☐Partage d'objectifs	☐Partage de valeurs	☐Communication avec le pilote
☐Partage de sens	☐Gestion du conflit	☐Organisation des rôles
☐Niveau d'autonomie	☐Résolution de problèmes	☐Suivi des performances
☐Niveau des performances		

SECTION 5 : **Vous et l'amélioration continue**

Quel est votre état d'esprit par rapport à l'amélioration continue dans votre activité professionnelle ?

□ C'est quoi ce truc-là ?

□ Je vois plus ou moins à quoi ça sert…

□ J'ai régulièrement des idées d'amélioration (réalisables ou non)

□ J'en rêve la nuit 😊

Quelle part de votre activité est occupée par des activités d'amélioration continue (résolution de problème, mise en place d'action, 5S, …) ?

□ Moins de 10% (quelques heures par semaine)

□ De 10% à 30% (équivalent à 1 jour par semaine)

□ 30% à 60% (2 jours par semaine)

□ 60% à 90% (3 jours par semaine)

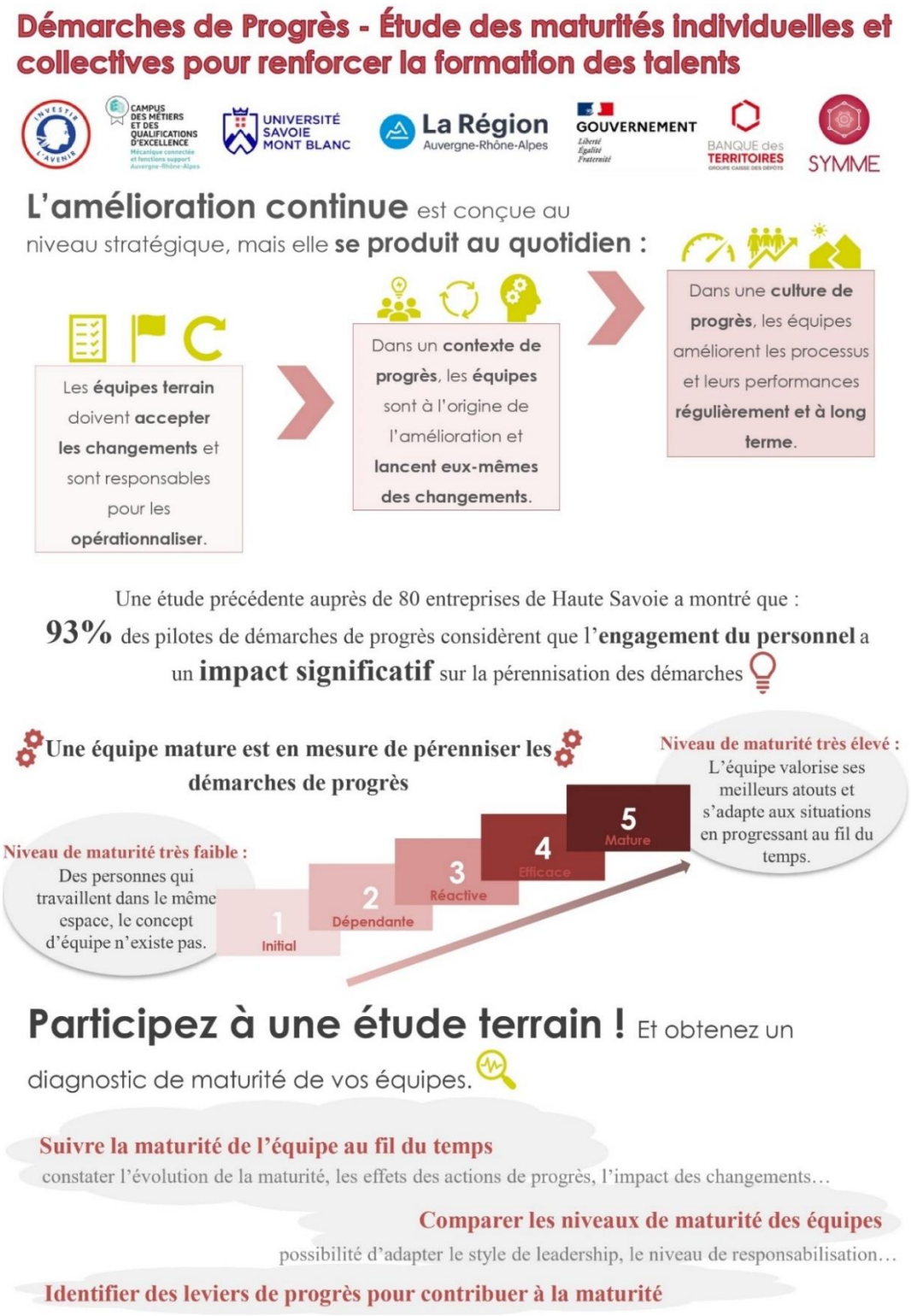
□ 90% ou + (+ de 3 jours par semaine)

Merci beaucoup pour votre participation !

N'hésitez pas à nous contacter si vous avez des questions, remarques, etc. :

gabriella.gambarra-moreira@univ-smb.fr

Appendix 2: Invitation brochure for study participation



Étude terrain : les étapes

Diagnostic de la maturité des équipes et identification des leviers d'action pour la renforcer

Étape 1 : Questionnaire à compléter par les membres de l'équipe terrain (temps estimé : 30 minutes)

- Mesurer la maturité de l'équipe à travers l'évaluation de ses membres
- Collecter des leviers et des actions permettant de renforcer les caractéristiques de maturité

Étape 2 (facultative) : Rencontre avec le pilote de démarches de progrès (temps estimé : 60 minutes)

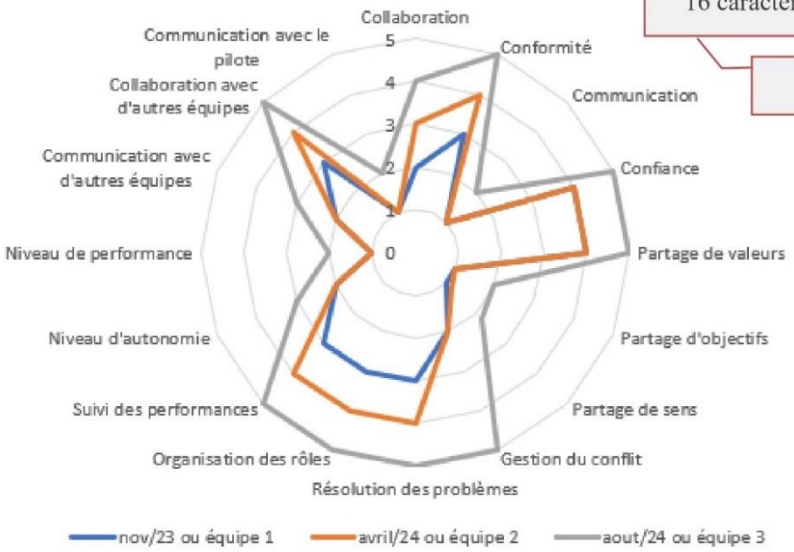
- Présentation des résultats au pilote de démarches de progrès
- Discussion sur les leviers et actions pour renforcer la maturité des équipes

Favoriser la dynamique de progrès

Faire réfléchir l'équipe sur sa maturité :
Un niveau élevé de maturité de l'équipe favorise le bien être des talents et crée un sentiment collectif d'appartenance

Questionnaire d'évaluation : 16 questions sur 16 caractéristiques de maturité d'équipe

5 niveaux de réponses



D'avance merci pour votre contribution à la recherche en pays de Savoie !

Gabriella Gambarra : gabriella.gambarra-moreira@univ-smb.fr

Encadrement : Magali Pralus, Julien Boissière, Georges Habchi

Appendix 3: Correlation analysis

Correlations

			Communication	Collaboration	Trust	Conformity	Shared goals	Shared values	Shared meaning	Conflict management	Roles organization in the team	Autonomy	Participatory problem solving	Performance monitoring between members	Performance level	Communication with the program manager	Communication with other teams	Collaboration with other teams
Rho de Spearman	Communication	Correlation coefficient	1,000	,537**	,475**	,426**	,492**	,395**	,310**	,484**	,409**	,407**	,427**	,262*	,419**	0,199	,268*	0,089
	Collaboration	Correlation coefficient	,537**	1,000	,639**	,432**	,539**	,524**	,549**	,482**	,432**	0,182	,432**	,478**	,482**	,276*	,428**	,385**
	Trust	Correlation coefficient	,475**	,639**	1,000	,476**	,540**	,681**	,536**	,596**	,432**	,262*	,468**	,424**	,480**	0,203	,435**	,370**
	Conformity	Correlation coefficient	,426**	,432**	,476**	1,000	,595**	,526**	,433**	,450**	,474**	,267*	,448**	,445**	,572**	,431**	0,196	,418**
	Shared goals	Correlation coefficient	,492**	,539**	,540**	,595**	1,000	,656**	,577**	,396**	,562**	,320**	,479**	,418**	,600**	,349**	,442**	,349**
	Shared values	Correlation coefficient	,395**	,524**	,681**	,526**	,656**	1,000	,569**	,526**	,416**	,392**	,604**	,497**	,484**	,310**	,325**	,376**
	Shared meaning	Correlation coefficient	,310**	,549**	,536**	,433**	,577**	,569**	1,000	,463**	,429**	,252*	,541**	,481**	,534**	,301**	,349**	,404**
	Conflict management	Correlation coefficient	,484**	,482**	,596**	,450**	,396**	,526**	,463**	1,000	,510**	,411**	,579**	,256*	,400**	0,134	,286**	0,192
	Roles organization in the team	Correlation coefficient	,409**	,432**	,432**	,474**	,562**	,416**	,429**	,510**	1,000	,447**	,537**	,359**	,439**	0,173	,366**	,291**
	Autonomy	Correlation coefficient	,407**	0,182	,262*	,267*	,320**	,392**	,252*	,411**	,447**	1,000	,437**	,236*	,380**	0,133	0,127	0,096
	Participatory problem solving	Correlation coefficient	,427**	,432**	,468**	,448**	,479**	,604**	,541**	,579**	,537**	,437**	1,000	,458**	,498**	,341**	,361**	,387**
	Performance monitoring between members	Correlation coefficient	,262*	,478**	,424**	,445**	,418**	,497**	,481**	,256*	,359**	,236*	,458**	1,000	,470**	,438**	,216*	,437**
	Performance level	Correlation coefficient	,419**	,482**	,480**	,572**	,600**	,484**	,534**	,400**	,439**	,380**	,498**	,470**	1,000	,423**	0,197	,356**
	Communication with the program manager	Correlation coefficient	0,199	,276*	0,203	,431**	,349**	,310**	,301**	0,134	0,173	0,133	,341**	,438**	,423**	1,000	,251*	,410**
	Communication with other teams	Correlation coefficient	,268*	,428**	,435**	0,196	,442**	,325**	,349**	,286**	,366**	0,127	,361**	,216*	0,197	,251*	1,000	,499**
	Collaboration with other teams	Correlation coefficient	0,089	,385**	,370**	,418**	,349**	,376**	,404**	0,192	,291**	0,096	,387**	,437**	,356**	,410**	,499**	1,000

**. The correlation is significant at the 0.01 level (two-tailed).

*. The correlation is significant at the 0.05 level (two-tailed).

Correlation coefficients	Interpretation
0.00 - .20	Very weak
.21 - .40	Weak
.41 - .60	Moderate
.61 - .80	Strong
.81 - 1.00	Very strong

Appendix 4: Suggestions of respondents to improve maturity of elements

Maturity element and placement	**Number of suggestions**	**Example 1 of suggestion**	**Example 2 of suggestion**	**Example 3 of suggestion**
Collaboration (2nd)	19	“The recognition of this spontaneous collaboration”	“To collaborate even when everything is going well”	“To be more attentive and maintain the willingness to collaborate, even when the atmosphere is not favorable”
Conformity (4th)	14	“More managerial presence in the field”	“Regular reminders of best practices”	“Clearer, more precise, up-to-date, and logical rules”
Communication openness (1st)	23	“More team meetings with managers when they are present”	“Having friendly and convivial moments at certain times”	“A better cohesion within the group”
Trust (3rd)	8	“More training and qualifications (they exist, but are consistently delayed, so no one gets qualified)”	“Strengthen the bonds between operators through social moments and opportunities for sharing”	“Fostering a good atmosphere within the team to build trust”
Shared goals (5th)	13	“Making each team's objectives known to all departments”	“Understanding one's own constraints and those of others in order to better adapt one's objectives”	“Regular communication from management about the objectives to be achieved”
Shared values (6th)	7	“Trust, exchange, conviviality, mutual support, communication”	“Form teams by grouping individuals within similar age ranges”	“It depends on each individual's personality and background, complex to evolve”

Maturity element and placement	Number of suggestions	Example 1 of suggestion	Example 2 of suggestion	Example 3 of suggestion
Shared meaning (7th)	11	“More training on products/clients, and applications”	“More quality”	“Some believe it's a trivial job, while in reality, it is not"
Conflict management (8th)	14	“Lack of communication and hierarchical intervention”	“Learning to communicate when things are not going well”	“More dialogue”
Participatory problem solving (11th)	12	“Sharing the problems encountered and the solutions implemented”	“The team is not necessarily familiar with the machines”	“Our hierarchy prevents us from solving problems on our own”
Roles organization in the team (9th)	10	“Ask team members before defining different roles”	“A clear organizational chart with a comprehensive scope of the roles within each department”	“Get along well with each other”
Performance monitoring between members (12th)	12	“Production display from the day before”	“Computer tool”	"To have overall recognition of the team"
Autonomy level (10th)	9	“To improve the willingness of managers to share knowledge and recognize employees, ensuring that skills remain within the company”	“Sometimes, we are required to seek help because the situation goes beyond what we learn in training”	“Provide clear explanations to the operator and teach them the correct method so that we can move forward”
Performance level (13th)	11	“Multiskilling and acknowledgment of well-executed work”	“Provide the resources to ensure improvement”	“Ensure regular training on tools”
Communication with other teams and departments (15th)	13	“More transparency between departments”	“Having annual or semi-annual cross-team initiatives (challenges, meetings, task forces, etc.)”	“Having dedicated moments for this communication”
Collaboration with other teams and departments (16th)	7	“Operators are not always trained on other tools. It is complex to implement”	“It's actually the opposite when introducing competition between teams”	“Meetings”
Communication with the Program manager (14th)	12	“Create a connection with the Program leader”	“Not enough communication, more dialogue is needed”	“Listening to everyone”

Résumé long en français

Titre : Amélioration Continue : Étude de la maturité des équipes pour renforcer les dynamiques de progrès

La mise en œuvre des projets d'amélioration continue (AC) demeure un défi majeur pour les organisations. En effet, si les aspects techniques de l'AC, tels que les outils et les méthodologies, sont bien établis et éprouvés, les taux d'échec élevés mettent en lumière une problématique plus profonde. Ce défi, loin d'être uniquement technique, est avant tout humain.

La réussite des projets d'AC dépend fortement des acteurs qu'ils soient managers ou opérationnels. En effet, l'amélioration est mise en application par les acteurs de terrain eux-mêmes, qui en sont souvent aussi à l'initiative. Dans ce contexte, mobiliser et engager ces acteurs est essentiel pour garantir la pérennité des démarches de progrès. Cependant, les approches actuelles, qu'il s'agisse de stratégies managériales ou de programmes de formation, s'avèrent souvent insuffisantes et peinent à intégrer les dynamiques humaines indispensables à cet engagement.

Ces dynamiques relèvent d'interactions multiples entre les individus, les équipes et leur environnement. Elles englobent des aspects relationnels et organisationnels complexes, difficilement traduisibles en actions techniques ou standardisées. Par ailleurs, elles ne peuvent reposer exclusivement sur des interventions externes, telles que celles des managers ; elles nécessitent également l'implication des acteurs eux-mêmes.

Pour répondre efficacement à cette problématique, nous proposons une approche pratique, centrée sur les acteurs de terrain. Dans cette perspective, cette thèse vise à apporter une contribution à un défi central auquel sont confrontées les organisations engagées dans des démarches d'AC : « **Comment mobiliser les équipes dans une dynamique d'AC pour pérenniser le progrès ?** »

Ce travail de thèse considère "l'équipe" comme une unité centrale et stratégique. C'est en effet sur un effort collectif et des pratiques de l'équipe que s'appuie l'AC. De plus, c'est au sein de l'équipe qu'ont lieu les plus fortes interactions entre acteurs. En introduisant le concept de maturité d'équipe, le travail proposé vise à intégrer ces interactions entre acteurs, ainsi que l'évolution de l'équipe dans son environnement.

Chapitre 1 : Une approche des dynamiques de l'AC centrée sur l'humain

Une analyse approfondie de la littérature sur l'AC révèle une lacune majeure : peu d'études explorent en profondeur la contribution des facteurs humains aux programmes d'AC. La majorité des travaux existants se concentre sur des pratiques ou compétences techniques, en négligeant les aspects relationnels et comportementaux. En particulier, il existe un manque d'évaluations globales qui vont au-delà des indicateurs de performance traditionnels pour inclure les dynamiques réelles des équipes et intégrer les perspectives des acteurs de terrain.

Les démarches d'AC peuvent générer des impacts négatifs sur les employés, en particulier lorsque le déploiement d'une telle démarche mène à l'intensification du travail ou augmente le niveau de stress lié au respect des normes ou standard. Dans ce cadre, un environnement d'équipe favorable peut

atténuer ces difficultés et améliorer l'implication des employés dans les démarches. Par ailleurs, le déploiement des démarches d'AC implique un changement profond des mentalités et des comportements, nécessitant une adhésion active aux transformations organisationnelles majeures plutôt qu'une résistance. Les équipes, par leur influence sur leurs membres, peuvent ainsi jouer un rôle décisif : elles peuvent agir comme levier de motivation ou facteur de démobilisation, et se positionner en catalyseurs ou en obstacles au changement.

Les dynamiques d'équipe s'inscrivent ainsi dans un système d'influences réciproques et continues entre l'équipe et ses membres. Dans cette optique, la notion de maturité d'équipe prend tout son sens. La notion de maturité doit être appréhendée en fonction du contexte dans lequel elle s'applique, et dans ce cas, la maturité d'équipe ne peut pas être dissociée des relations humaines.

La maturité, souvent associée à un état de développement accompli, a conduit à la création de modèles largement utilisés à des fins managériales pour évaluer des processus ou des organisations. Cependant, les rares modèles de maturité intégrant des dimensions humaines se concentrent principalement sur l'acquisition de compétences techniques, écartant les dynamiques relationnelles et comportementales intrinsèques. De plus, ces modèles négligent le point de vue des acteurs de terrain ainsi que les dynamiques propres aux équipes, ce qui limite leur capacité à saisir la complexité des réalités de terrain.

Dans le contexte de l'AC, de manière générale, les équipes doivent jouer un rôle important pour renforcer la contribution des membres et atténuer les potentiels effets négatifs associés au changement. D'autre part, les équipes de production évoluant dans des contextes d'AC se distinguent par des caractéristiques spécifiques qui les différencient des autres groupes. Ainsi, il apparaît pertinent d'étudier leur maturité. La maturité d'équipe peut constituer une approche globale permettant d'indiquer si une équipe est en mesure de pérenniser les démarches de progrès. En ce sens, viser un niveau élevé de maturité d'équipe peut s'imposer comme un objectif stratégique pour les organisations, dans un environnement qui exige une adaptation continue et une évolution perpétuelle.

Identifier les éléments clés de cette maturité d'équipe qui sont nécessaires au maintien des initiatives d'AC, permet de poser les bases d'un modèle structuré. Cette identification ouvre la voie à l'élaboration d'un modèle de maturité permettant d'évaluer le niveau de maturité des équipes et de soutenir, de manière ciblée, les dynamiques de progrès.

Ainsi, l'approche proposée est basée sur la maturité d'équipe et s'articule autour de trois étapes clés : identifier les caractéristiques de la maturité d'équipe dans le cadre des démarches d'AC, évaluer cette maturité dans le but de la piloter, et renforcer cette maturité par l'identification d'actions ciblées. Autrement dit, il est important de commencer par définir ce qu'est la maturité d'équipe dans un contexte de déploiement de l'AC. Par la suite, cette maturité pourra être évaluée à l'aide d'une méthodologie, puis renforcée grâce à un plan d'actions. En somme, l'objectif est de proposer une approche pratique

visant à intégrer les équipes terrain dans une dynamique d'AC pour pérenniser les démarches de progrès.

Chapitre 2 : Caractérisation de la maturité des équipes de production dans un contexte d'Amélioration Continue

Afin de caractériser la maturité des équipes d'AC, nous avons adopté une démarche en trois temps. Nous avons d'abord examiné les travaux issus du champ des recherches sur les dynamiques de groupe, ceci afin d'avoir une vision plus large que la seule notion d'équipe et dans le but de ne pas écarter des apports théoriques déjà établis. Cette première étape nous a ensuite permis de recentrer l'analyse sur les équipes de terrain évoluant dans un contexte spécifique d'AC. Enfin, ces 2 étapes d'analyses nous ont ensuite servi de base pour la caractérisation de la maturité des équipes terrain.

Étude des groupes dans des contextes variés :

Le corpus de recherche sur la notion de "groupes" est vaste et naturellement multidisciplinaire. La perception qu'ont les membres d'un groupe de leur cadre de travail joue un rôle central dans leur satisfaction, laquelle influence à son tour leur productivité. Dans cette optique, le contexte dans lequel les groupes évoluent agit sur leur perception et leur satisfaction, impactant ainsi leur engagement envers les objectifs collectifs et organisationnels.

Les travaux sur le développement des groupes indiquent que chaque groupe fonctionne à un certain niveau d'évolution, lequel influence directement d'autres aspects, tels que la performance. En ce sens, les stratégies organisationnelles visant à renforcer l'efficacité devraient prioriser l'accompagnement des équipes en tant que groupes et pas seulement au niveau des individus, afin de les aider à progresser vers des stades de développement plus avancés.

Il existe différents modèles décrivant le développement des groupes : certains suivent une séquence linéaire, d'autres adoptent une approche cyclique avec des phases récurrentes, tandis que certains décrivent une progression non séquentielle, marquée par des déclencheurs externes ou des événements critiques.

Quel que soit le type de progression suivi par les groupes dans les démarches d'AC, les modèles progressifs linéaires se révèlent particulièrement pertinents pour identifier les caractéristiques des groupes dits "développés". Par conséquent, une analyse systématique de la littérature a été conduite, en se concentrant sur l'identification d'un modèle de développement de groupe pertinent, susceptible de servir de référence pour l'étude de ces caractéristiques.

Bien qu'aucun des modèles existants n'ait été élaboré en tenant compte des spécificités des groupes dans des contextes d'AC, certains modèles sont considérés applicables à divers types de groupes et offrent une vision globale des dynamiques d'équipe. Parmi eux, les modèles de Tuckman (1965) et de Wheelan (1994) figurent parmi les plus reconnus et sont largement mobilisés dans les études sur le management des équipes.

C'est d'ailleurs ce modèle de Wheelan (1994) qui a été retenu comme base pour la suite des travaux. Susan Wheelan a étudié des centaines de groupes issus de contextes variés, notamment des équipes de travail, des groupes d'étudiants et des groupes de patients dans le cadre de thérapies collectives. Elle a collecté des données pour analyser leurs dynamiques à travers différentes phases de développement. Ces travaux ont conduit à l'élaboration de son modèle intégré de développement de groupe (IMGD), qui définit 5 stades de progression des groupes : Dépendance et inclusion, Contre-dépendance et conflit, Confiance et structuration, Travail, et Dissolution, cette dernière représentant le point final pour les groupes temporaires.

A partir de ce modèle, nous avons identifié 4 dimensions clés structurant les processus centraux de l'évolution des groupes : le Comportement du groupe, la Communication, les Liens entre individus et la Relation au travail. La figure 14 présente ces dimensions, chacune définie par une caractéristique principale selon son stade de développement.

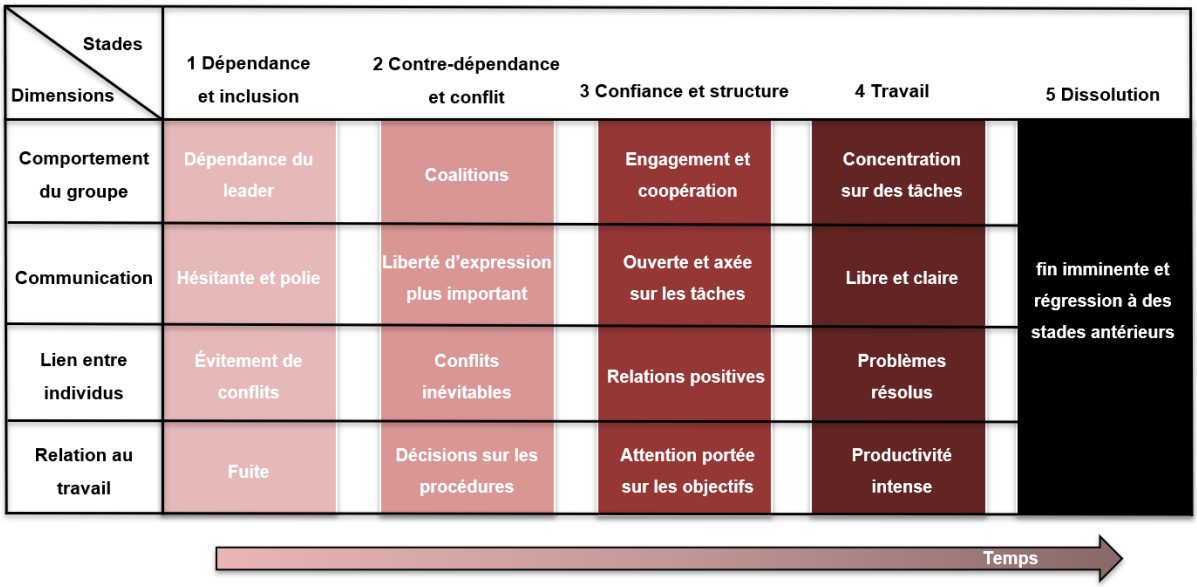


Figure 14: Les 4 dimensions de l'évolution d'un groupe, complétant les 5 phases définies par Wheelan 1994

Cette structure, organisée par dimensions, offre une vue d'ensemble des dynamiques au sein des groupes, et souligne que la progression dépend du temps et repose sur des dimensions qui évoluent de manière interdépendante.

Étude des équipes dans un contexte d'AC :

Pour recentrer la recherche sur le contexte de l'AC, une seconde revue systématique de la littérature (SLR) a été menée afin d'explorer le fonctionnement des équipes de terrain dans des contextes d'AC. Cette analyse a permis de sélectionner 11 études empiriques. Ces travaux, répartis sur les cinq continents, ont été réalisés principalement dans des environnements manufacturiers, certains couvrant également le secteur des services.

Ces 11 études ont majoritairement mis en lumière des aspects internes aux équipes qui correspondent à des caractéristiques essentielles que les équipes possèdent ou doivent acquérir pour pérenniser l'AC. L'étude de ces caractéristiques a permis d'identifier 14 éléments de maturité indispensables au soutien des programmes d'AC. Ces éléments sont présentés dans le tableau 1.

Tableau 1 : Éléments de maturité des équipes de terrain d'AC.

Eléments de maturité / Références	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Communication ouverte					✓	✓		✓	✓	✓	✓
Collaboration	✓			✓	✓		✓			✓	✓
Niveau d'autonomie		✓	✓				✓				✓
Niveau de performance				✓	✓					✓	✓
Partage d'objectifs			✓	✓	✓						✓
Collaboration avec d'autres équipes et départements			✓				✓				✓
Résolution participative de problèmes			✓		✓						✓
Partage de sens			✓		✓						✓
Communication avec le pilote de démarches de progrès									✓		
Communication avec d'autres équipes et départements									✓		
Suivi des performances entre les membres										✓	
Organisation des rôles dans l'équipe											✓
Partage de valeurs										✓	
Confiance								✓			

1- Jaca *et al.* (2012) ; 2- Rolfsen and Langeland (2012) ; 3- Lantz *et al.* (2015) ; 4- Grant and Hallam (2016) ; 5- Wang *et al.* (2016) ; 6- Berlec *et al.* (2017); 7- De Vries and Van der Poll (2018) ; 8- Hansen *et al.* (2020) ; 9- Colazo (2020) ; 10- Van Dun and Wilderom (2021) ; 11- Tortorella *et al.* (2021).

Les résultats des 2 études bibliographiques (IMGD et AC) ont été confrontés aux avis de 2 experts en AC, confirmant ainsi la pertinence de la recherche et la validité des éléments de maturité identifiés. Cette consolidation des trois sources a abouti à une caractérisation de la maturité d'équipe.

Caractérisation de la maturité d'équipe :

Les 14 éléments de maturité issus de la littérature sur l'AC (Tableau 1) ont été confrontés à la littérature relative à l'IMGD. Il en ressort que 8 éléments de maturité sont abordés à la fois par la littérature sur l'AC et celle relative à l'IMGD. En revanche, 6 éléments de maturité, absents de la littérature IMGD, se révèlent significatifs pour les équipes de terrain déployant l'AC, comme l'ont confirmé les experts en AC. Enfin, 2 éléments de maturité, *Conformité* et *Gestion du Conflit*, absents de la littérature d'AC,

ont été identifiés comme des traits importants des groupes développés dans l'IMGD, eux aussi validés par les experts en AC.

Au final, comme représenté dans la figure 15, 16 éléments de maturités, chacun appuyé par au minimum 2 sources distinctes, ont été identifiés.

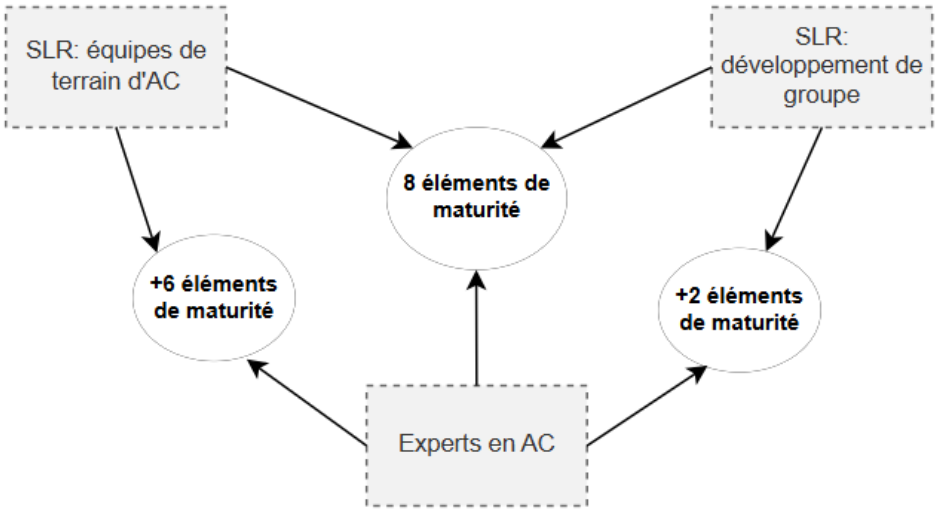


Figure 15: Sources for the 16 maturity elements

Par la suite, ces 16 éléments de maturité ont été répartis dans les 4 dimensions initiales issues de l'IMGD (figure 14). Une cinquième dimension, Liens externes, a été ajoutée à cette caractérisation afin d'inclure les éléments relatifs aux relations externes des équipes avec d'autres équipes, départements et managers. En effet cette dimension était absente des études sur l'IMGD, alors qu'elle caractérise des éléments clés dans l'AC.

La caractérisation de la maturité d'équipe, composée de 5 dimensions et 16 éléments de maturité, est illustrée dans la figure 16.

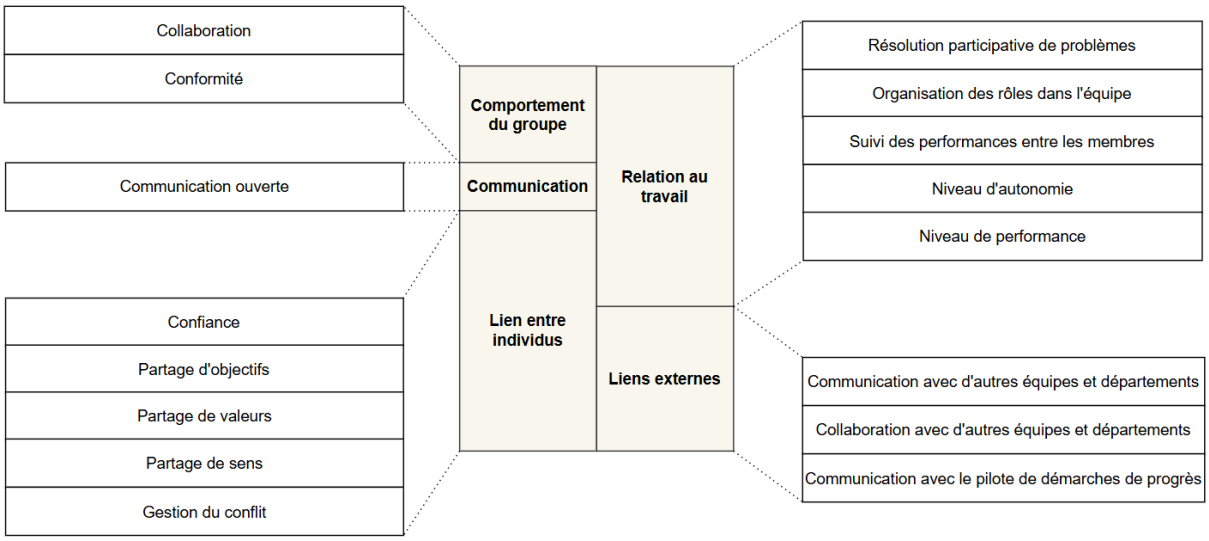


Figure 16: Caractérisation de la maturité d'équipe

Ce cadre offre une vision d'ensemble des dynamiques des équipes de terrain d'AC et met en lumière les éléments qui façonnent leur maturité. Il constitue une base solide pour développer des outils d'évaluation efficaces, visant à renforcer la maturité des équipes afin de soutenir les initiatives d'AC.

Les principales contributions de la méthodologie que nous avons adoptée et de la caractérisation que nous proposons de la maturité d'équipe, tant sur le plan conceptuel que pratique, sont :

- une structuration du modèle IMGD (modèle d'évolution des groupes) en 4 dimensions,
- l'association de 2 disciplines distinctes : le développement des groupes et l'AC ; introduisant une nouvelle perspective pour les équipes dans le domaine de l'AC,
- une caractérisation de la maturité d'équipe complète et adaptée au contexte des démarches d'AC qui facilitera le développement d'outils d'évaluation et ainsi l'amélioration de la maturité des équipes,
- la prise en compte des conditions du terrain grâce à l'utilisation exclusive d'études empiriques issues des 2 revues de la littérature et complétées par les avis d'experts.

Nous proposons ainsi un cadre pratique reposant sur une base théorique solide, présentant les éléments de maturité de manière claire et accessible pour les praticiens de l'AC.

Chapitre 3 : Vers un Processus Conceptuel de l'Amélioration de la Maturité d'Équipe

La théorie adoptée sur le développement des groupes suggère que la maturité d'équipe se développe avec le temps. Quelle que soit l'influence du temps sur cette maturité - qu'il favorise une progression, une régression ou une navigation non linéaire entre les stades de développement - envisager la maturité d'équipe comme un processus dynamique de développement peut s'avérer particulièrement pertinent dans une optique d'amélioration. Cette approche ouvre la voie au pilotage de la maturité d'équipe et à son renforcement.

À cet égard, la figure 17 illustre notre proposition d'un **processus conceptuel d'amélioration de la maturité d'équipe** (CTMIP – Conceptual Team Maturity Improvement Process). Dans ce processus conceptuel, les dynamiques des équipes ont été identifiées à travers une caractérisation de leur maturité. En fonction du niveau de maturité et de l'évaluation des équipes, des actions d'amélioration ciblées peuvent être déployées.

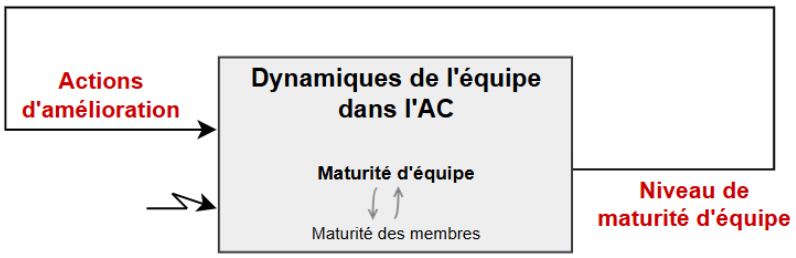


Figure 17: Processus conceptuel d'amélioration de la maturité d'équipe (CTMIP)

Ce processus intègre également la relation réciproque entre la maturité individuelle des membres de l'équipe et celle de l'équipe dans son ensemble. Étant donné que les équipes jouent un rôle déterminant dans les résultats organisationnels, les actions visant à renforcer la maturité d'équipe favorisent également une amélioration de la maturité individuelle des membres. Par ailleurs, bien que la maturité ne puisse être manipulée directement, son développement est fortement influencé par des facteurs contextuels. Identifier ces facteurs au sein des organisations peut donc contribuer à concevoir des actions pour renforcer la maturité des équipes.

En somme, le CTMIP s'articule autour de l'évaluation de la maturité d'équipe sur la base des éléments de maturité préalablement définis. Nous proposons ensuite une méthode structurée pour l'évaluation, par les membres de l'équipe eux-mêmes, de ces éléments de maturité. La comparaison des résultats obtenus avec des objectifs de maturité préalablement définis permet ensuite de concevoir des actions d'amélioration adaptées.

Évaluation de la maturité d'équipe :

Un modèle de maturité d'équipe a été conçu en suivant les procédures définies par Becker *et al.* (2009). Ce modèle, présenté dans la figure 18, est structuré en 5 niveaux de maturité : Initial, Dépendant, Réactif, Efficace et Mature. Les 16 éléments de maturité, regroupés en 5 dimensions, constituent les critères qui définissent la maturité d'une équipe.

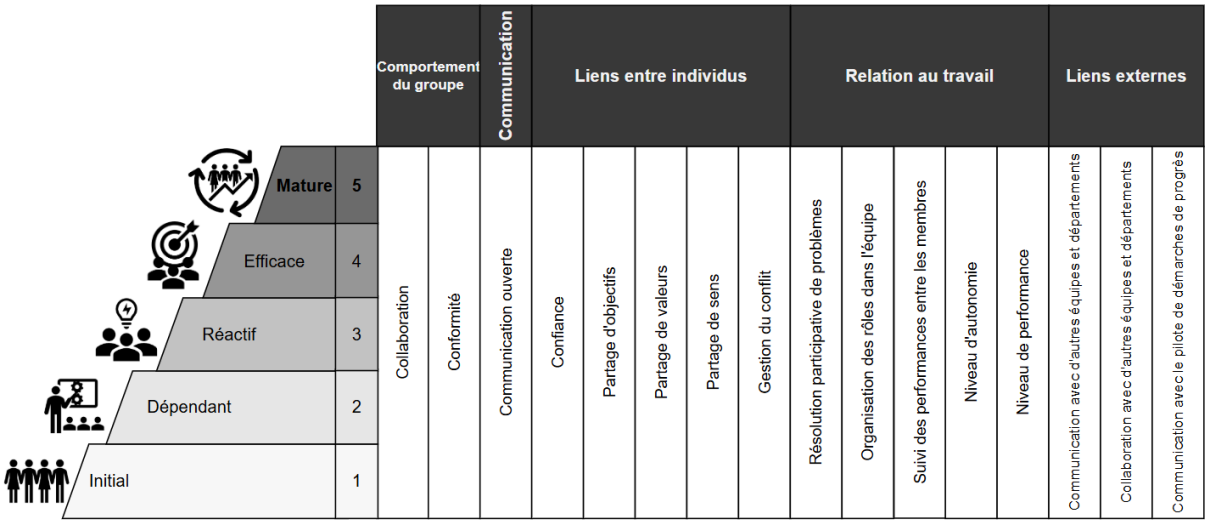


Figure 18: Le modèle de maturité d'équipe

Concernant les 5 niveaux de maturité, ils peuvent être décrits de la manière suivante :

- Initial : l'équipe fonctionne davantage comme un groupe d'individus partageant un même espace de travail que comme une véritable équipe. Il n'existe ni structure définie, ni conscience ou engagement envers des démarches de progression, ce qui se traduit par des résultats collectifs très limités.
- Dépendant : l'équipe dépend du management ou de facteurs externes pour que des pratiques de maturité puissent émerger. Bien que certaines de ces pratiques apparaissent ponctuellement,

elles demeurent irrégulières et peu intégrées à la dynamique collective, ce qui limite leur impact sur la performance de l'équipe.

- Réactif : l'équipe montre une capacité à mettre en œuvre des pratiques matures, mais uniquement en réponse à des situations spécifiques. Elle adopte une posture réactive plutôt que proactive. Les améliorations restent ainsi circonstancielles et ne s'inscrivent pas dans une démarche systématique ou un engagement collectif envers l'amélioration continue.
- Efficace : l'équipe applique de manière cohérente et régulière des pratiques matures, et fonctionne comme une unité soudée. Ces pratiques sont intégrées dans le quotidien, ce qui permet l'optimisation des processus et la mise en place de méthodes fiables au service de la performance.
- Mature : l'équipe atteint un stade avancé de maturité et entre ainsi dans une dynamique d'amélioration continue. Les pratiques matures font partie intégrante de la culture d'équipe. À ce niveau, l'engagement envers l'AC est fort et la progression est activement recherchée par les membres.

Dans cette optique, et afin de garantir une évaluation pratique, chaque élément de maturité peut être analysé individuellement selon les différents niveaux de maturité. Nous avons élaboré un questionnaire d'évaluation visant non seulement à mesurer la maturité d'équipe à travers l'évaluation par les membres de l'équipe, ce qui conduit également à impliquer activement chaque membre dans le processus. Par ailleurs, recueillir les contributions individuelles de tous les membres est essentiel pour limiter les biais, tels que la pression de groupe ou une vision limitée basée sur les perceptions de quelques membres.

Ainsi, le questionnaire élaboré complète le modèle de maturité d'équipe en permettant d'évaluer la maturité des équipes par l'analyse individuelle de chaque élément, selon les niveaux définis, à partir de l'autoévaluation réalisée par les membres de l'équipe. Cette approche, axée sur la praticité, permet d'obtenir une vision claire et globale de la maturité d'équipe de la manière suivante :

- La moyenne des évaluations de l'ensemble des membres pour les 16 éléments de maturité fournit la maturité globale de l'équipe ;
- La moyenne des évaluations de l'ensemble des membres pour 1 élément spécifique reflète le niveau global de maturité de cet élément ;
- La moyenne des évaluations des 16 éléments par un membre individuel reflète sa perception de la maturité globale de l'équipe.

Le modèle de maturité d'équipe s'appuie sur de la littérature empirique et sur les avis d'experts de terrain, issus de la caractérisation de la maturité d'équipe. De plus, ce modèle a fait l'objet d'une validation externe par 3 experts, conformément aux recommandations de Becker *et al.* (2009). Au total, 5 praticiens d'AC ont contribué à sa construction en validant à la fois les éléments de maturité et la structure du modèle.

Amélioration de la maturité d'équipe :

Les résultats de l'évaluation de la maturité d'équipe permettent d'identifier les éléments nécessitant des améliorations. Cependant, identifier des actions d'amélioration directement associées à un élément de

maturité spécifique peut s'avérer complexe, car de nombreuses actions ont un impact transversal sur plusieurs éléments. Par exemple, une formation à la résolution de problèmes, bien qu'elle cible un élément particulier tel que la *Résolution participative des problèmes*, peut également influencer d'autres aspects, comme la *Collaboration*, l'*Autonomie,* et potentiellement davantage. Ces interconnexions entre les éléments mettent en évidence non seulement la complexité de concevoir des actions d'amélioration, mais aussi les bénéfices organisationnels élargis qu'elles peuvent générer, au-delà de l'objectif initial.

En outre, la littérature fournit une perspective limitée sur les effets des actions menées sur les éléments de maturité. L'efficacité de ces actions est fortement contextuelle : des facteurs externes et internes peuvent influencer la réussite ou l'échec d'une stratégie donnée.

Dans cette perspective, plutôt que d'élaborer une liste d'actions spécifiques pour un ou plusieurs éléments de maturité, une analyse bibliographique des mêmes sources ayant servi à la caractérisation de la maturité (l'IMGD et la revue systématique sur l'AC) a permis d'identifier les principaux facteurs contribuant à l'amélioration globale de la maturité des équipes. Cette analyse a conduit à la définition de 3 axes d'intervention distincts et de 11 influenceurs de maturité (Tableau 2). Les axes d'intervention correspondent aux grandes dimensions structurelles ou conjoncturelles de l'organisation influençant la maturité des équipes, tandis que les influenceurs de maturité représentent des leviers spécifiques au sein de ces axes.

La formulation des axes d'intervention et des influenceurs de maturité constitue un cadre précieux pour l'élaboration d'un plan d'amélioration, en orientant les managers vers des actions ciblées qui répondent à leurs besoins spécifiques.

En complément, l'évaluation de la maturité d'équipe peut inclure une question ouverte invitant les membres de l'équipe à formuler des propositions pour améliorer les éléments de maturité. En tant qu'acteurs directement impliqués, ils disposent d'une perspective unique pour exprimer leurs besoins et priorités.

Une approche centrée sur la maturité d'équipe :

Le CTMIP constitue une structure conceptuelle intégrant les objectifs de recherche visant à identifier, évaluer et renforcer la maturité des équipes de terrain d'AC. La figure 19 propose une mise en perspective du CTMIP, en soulignant les résultats de recherche obtenus dans ses trois composantes principales.

Bien que l'élaboration de plan d'actions soit, par essence même, un pilier central des programmes d'AC, ce qui distingue le CTMIP est son approche innovante centrée sur la maturité d'équipe. Idéalement, le CTMIP incite les membres d'équipe à réfléchir sur leur propre maturité, tout en les engageant et en les responsabilisant dans ce processus d'évolution. Cependant, une diffusion inadéquate de cette approche pourrait amener les équipes à percevoir l'évaluation de la maturité comme un simple outil de contrôle, plutôt que comme une opportunité de développement collectif.

Tableau 2 : Axes d'intervention et influenceurs de maturité d'équipe.

Axes d'intervention	**Influenceurs de maturité**	**Références et Recommandations**
Conditions de travail	Sécurité	Réduction des accidents mineurs [5] ; Mise en place d'une méthode de sécurité impliquant la confirmation verbale des actions critiques pour renforcer la vigilance et réduire les erreurs [5].
	Infrastructure	Délimitation d'un territoire de travail défini pour l'équipe [1] ; Création d'espaces communs pour les pause-café et les repas [9].
	Horaires de travail	Employés travaillant à temps plein [6 ; 10] ; Élimination, dans la mesure du possible, du travail de nuit [9].
	Taille des équipes	Les équipes sont composées du nombre minimum de membres nécessaire pour atteindre leurs objectifs, tout en permettant aux responsables d'équipe de gérer un périmètre raisonnable [1 ; 7 ; 8 ; 4].
	Adéquation des tâches	Les tâches offrent de la diversité et des défis [1] ; Les tâches sont adaptées à une résolution collective plutôt qu'individuelle [1] ; Les rôles sont attribués en fonction des compétences des membres [1].
Disponibilité des ressources	Formation	Mise à disposition des formations [2] ; Accès à des formations techniques ou en relations humaines selon les besoins [1].
	Accès aux ressources	Disponibilité des ressources techniques et humaines nécessaires à la réalisation des tâches [1] ; Accès à des experts techniques ou interpersonnels si nécessaire [1] ; Ressources dédiées aux pratiques d'AC [10].
	Maturité en AC	Niveau général de maturité en AC au sein de l'organisation [10] ; Mise en œuvre de réunions sur tableau blanc et de procédures standardisées pour traiter les écarts [9] ; Présence d'un leader d'équipe actif et officiellement reconnu [8] ; Soutien d'un responsable AC [6].
Contexte organisationnel	Pratiques organisationnelles	Clarté stratégique et structurelle [10] ; Compétitions de compétences et récompenses pour encourager les améliorations [5] ; Empowerment, délégation et participation à la prise de décision [1 ; 8 ; 3] ; Gestion proactive des absences pour maladie [9].
	Culture	Contrôle pour éviter une pression excessive liée au temps et à la performance [7] ; Soutien à la sensibilisation aux objectifs et à la communication entre les membres de l'équipe [7] ; Adoption de valeurs de dépassement de soi et d'ouverture au changement chez les dirigeants de haut niveau [3] ; Changement culturel [2].
	Soutien managérial	Style de leadership adapté au niveau de développement du groupe [1] ; Présence fréquente sur le terrain et interactions directes régulières [9 ; 10] ; Soutien managérial aux initiatives de changement [9 ; 2] ; Reconnaissance et valorisation des équipes [5 ; 2].

1- Wheelan and Hochberger (1996) ; 2- Jaca *et al.* (2012) ; 3- Lantz *et al.* (2015) ; 4- Van Dun and Wilderom (2016) ; 5- Wang *et al.* (2016) ; 6- Nasim and Iqbal (2019) ; 7- Hansen *et al.* (2020) ; 8- Tortorella *et al.* (2021) ; 9- Halling *et al.* (2021) ; 10- Van Dun and Wilderom (2021).

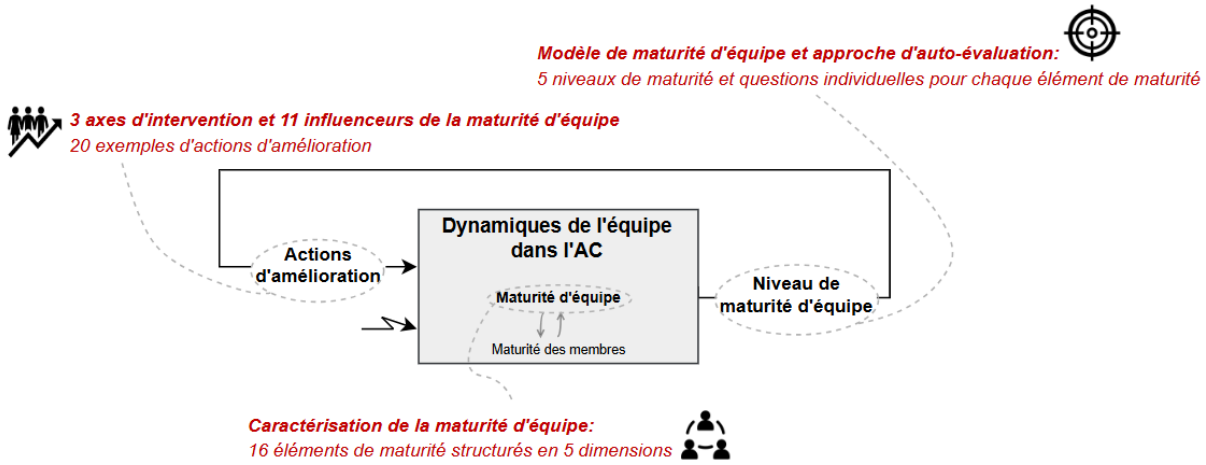


Figure 19: Processus conceptuel d'amélioration de la maturité d'équipe (CTMIP) revisité

Chapitre 4 : Évaluation de la maturité d'équipe à travers 2 études de cas

Alors que le CTMIP repose sur un cadre théorique solide, la prochaine étape consiste à tester cette approche en conditions réelles afin d'évaluer sa viabilité. Cependant, compte tenu du temps limité disponible pour cette phase de recherche pratique, les applications se concentreront sur le modèle de maturité d'équipe et l'approche d'autoévaluation proposés.

La mise en œuvre pratique du modèle est indispensable pour tester sa robustesse et sa généralisation, et formuler des recommandations précises sur son application. En ce sens, une méthode d'étude de cas a été retenue pour cette recherche. Elle vise à tester et à évaluer l'application pratique du modèle de maturité d'équipe ainsi que l'approche d'évaluation auprès d'équipes de terrain impliquées dans une démarche d'amélioration continue. Cette étude a pour objectif de déterminer la pertinence du modèle de maturité pour les entreprises engagées dans des démarches d'AC.

Un questionnaire d'auto-évaluation est conçu comme outil principal de collecte des données. En complément, une interview semi-structurée est prévue avec l'entreprise après l'évaluation, afin de recueillir des retours sur le processus déployé et les résultats.

Le questionnaire d'auto-évaluation est conçu pour permettre aux membres des équipes d'évaluer leur équipe en fonction de leurs perceptions individuelles. Il comprend 16 questions, chacune correspondant à l'un des 16 éléments de maturité. Pour chaque question, les répondants ont le choix entre 5 options reflétant les 5 niveaux de maturité définis pour chaque élément. Ces options, élaborées à partir de concepts issus de la littérature et enrichies par les contributions d'experts, offrent un cadre détaillé et structuré, conçu pour guider les répondants et les aider à se positionner de manière précise et réfléchie.

Lors de l'évaluation, la méthode d'administration du questionnaire a été laissée à la discrétion des entreprises. L'objectif était d'observer comment elles s'approprieraient l'étude sur la maturité des équipes. Par la suite, à partir de l'analyse des données issues du questionnaire, un rapport est élaboré pour chaque entreprise, détaillant les résultats de maturité obtenus. La figure 20 présente les principales

informations contenues dans ce rapport, avec quelques illustrations graphiques pour une meilleure visualisation.

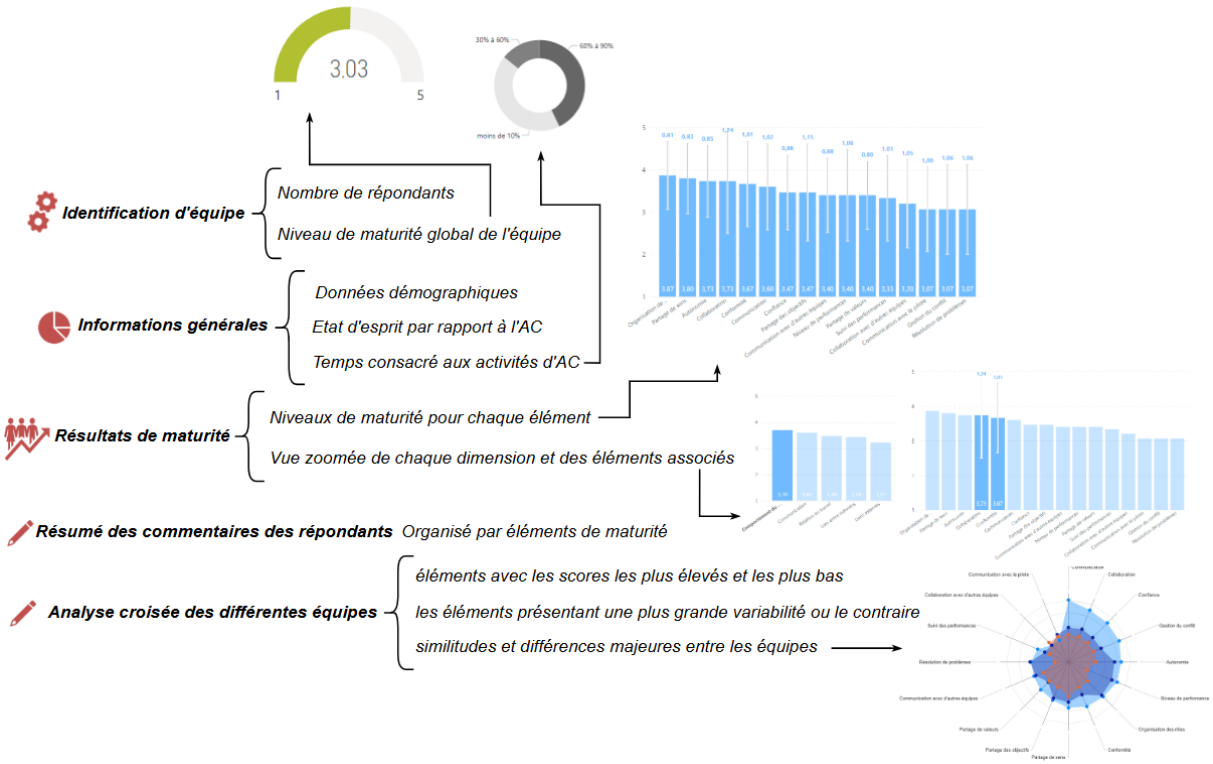


Figure 20: Sections principales du rapport pour chaque entreprise.

En résumé, l'analyse des résultats de maturité d'équipe vise à identifier les éléments présentant les scores les plus élevés et les plus faibles, ainsi que les zones de variabilité ou de cohérence significatives dans les réponses. Elle explore également les similitudes et divergences majeures entre les équipes. Par exemple, les scores de maturité des équipes travaillant dans une même unité de production peuvent être regroupés et comparés à ceux d'autres unités, permettant d'identifier des tendances spécifiques selon les contextes. De plus, les réponses de tous les membres de l'équipe sont intégrées dans les calculs afin de garantir une représentation fidèle, en particulier pour les équipes de petite taille. Toutefois, les réponses particulièrement atypiques peuvent également être signalées dans le cadre de l'analyse.

À l'issue de la phase préparatoire des études de cas, 2 entreprises ont été sélectionnées. L'une d'entre elles prévoyait de déployer l'évaluation de la maturité sur 3 sites de production distincts en France, tandis que l'autre prévoyait une mise en œuvre sur un seul site de production.

Au total, les évaluations de maturité ont été recueillies auprès de 85 répondants répartis dans 13 équipes de terrain issues des 2 entreprises et de 4 sites de production. L'évaluation de la maturité a été réalisée dans des contextes variés et selon des protocoles d'évaluation distincts. Le tableau 3 présente les principales différences contextuelles entre les deux études de cas.

Tableau 3 : Principales différences sur le contexte et le protocole d'évaluation des 2 études de cas

Points	**Entreprise E1**	**Entreprise E2**
Contexte d'évaluation : programme d'AC et équipes de terrain	Les initiatives d'AC sont principalement pilotées par l'équipe support Méthodes, avec une implication limitée des équipes de terrain	Les équipes de production sont activement impliquées dans les initiatives d'AC et reçoivent régulièrement des formations liées à l'AC
Stratégie de communication pour le processus d'évaluation	Chaque site a géré la communication en interne, présentant l'évaluation de la maturité comme une étude globale incluant toutes les équipes (production et support)	La diffusion de l'évaluation de la maturité a été initiée auprès des managers directs, puis progressivement étendue aux équipes de terrain, garantissant ainsi une compréhension partagée et une adhésion complète de tous les membres concernés
Processus d'évaluation	Introduction à l'étude sur la maturité d'équipe et explication générale du questionnaire d'évaluation	Les répondants ont été guidés question par question, avec des exemples contextuels détaillant les options de réponse pour faciliter leur compréhension
Rôle du facilitateur de l'étude	Le facilitateur supervise la performance sur l'ensemble des sites, ce qui limite les contacts directs avec les équipes de terrain	Les facilitateurs sont basés sur le site où l'étude est menée et entretiennent des liens plus étroits avec les équipes de terrain

Les résultats de maturité d'équipe des deux entreprises (E1 et E2) peuvent être comparés en fonction des niveaux de maturité des équipes ainsi que de la dispersion des évaluations parmi les répondants d'une même équipe. La figure 21 offre une vue d'ensemble de ces résultats.

En résumé, les études de cas distinctes et les résultats associés ont permis de dégager des conclusions structurées autour de trois thématiques principales : la viabilité de l'approche et la définition d'un protocole optimisé pour l'évaluation de la maturité d'équipe, la pertinence des éléments de maturité, et le potentiel pour engager des équipes de terrain dans un cycle d'amélioration, contribuant ainsi au soutien des initiatives d'AC.

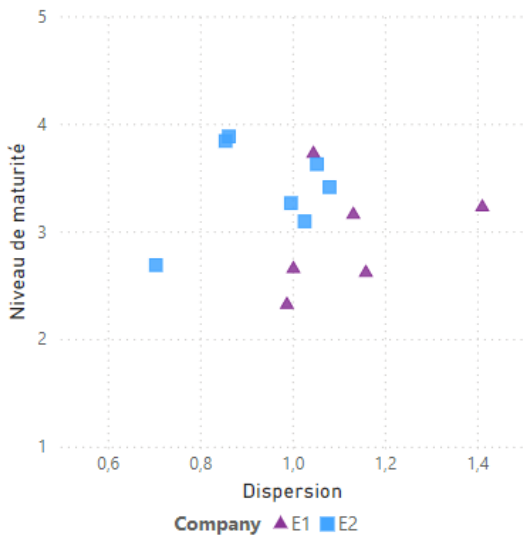


Figure 21: Dispersion des réponses et niveaux de maturité des équipes

Viabilité de l'évaluation de la maturité d'équipe et protocole d'évaluation optimal :

Les retours des 2 entreprises ont confirmé la cohérence des résultats de maturité par rapport à leur perception de maturité ainsi que la faisabilité de l'application du questionnaire d'évaluation auprès des équipes de terrain. Ces résultats renforcent la viabilité de l'approche d'évaluation de la maturité d'équipe et attestent de son efficacité pour mesurer "objectivement" la maturité des équipes de terrain d'AC.

Le processus d'évaluation mis en place par l'entreprise E2 a réduit la dispersion des réponses par rapport à l'entreprise E1 et a inspiré l'élaboration d'un protocole plus efficace pour l'évaluation de la maturité d'équipe. Ce nouveau protocole répond à 2 problèmes majeurs de l'évaluation de maturité : d'une part, la fatigue des répondants face à la longueur du questionnaire, et d'autre part, le risque de mauvaise interprétation des questions et des options de réponse. Cependant, il nécessite un investissement temporel plus important de la part des entreprises, tant pour s'approprier pleinement le questionnaire en amont que pour allonger le processus d'évaluation afin d'assurer une explication détaillée de chaque question.

L'objectif principal de l'étude était de proposer une approche pratique et facilement applicable par les entreprises, ce qui a également guidé la conception du questionnaire d'évaluation. Chaque élément de maturité a été abordé par une seule question ciblée, permettant de réduire l'effort et le temps requis des répondants tout en simplifiant l'analyse et l'interprétation des résultats pour les entreprises.

De plus, la structure du rapport d'évaluation fourni après le traitement des données, qui met en lumière les points forts de maturité et les éléments nécessitant une amélioration, a été non seulement bien comprise, mais aussi adoptée par l'une des entreprises dans leur retour.

Mettre en évidence les disparités de maturité entre les équipes, présentées dans le rapport d'évaluation à l'aide de graphiques radar, permet d'établir des comparaisons internes. L'entreprise E2 a souligné,

dans ses retours, l'importance de ces comparaisons, expliquant avoir délibérément sélectionné des équipes aux niveaux de maturité contrastés pour participer à l'évaluation. Cette stratégie leur a permis de mieux comprendre les différences existantes et de réfléchir aux facteurs contribuant à ces variations de maturité. À noter ici que le benchmarking interne peut constituer une étape clé pour concevoir un plan d'amélioration de la maturité efficace.

Pertinence des éléments de maturité :

Les évaluations de maturité réalisées auprès des 85 répondants ont apporté des informations précieuses sur les éléments de maturité. Les éléments présentant une forte dispersion des réponses, tels que *Suivi des performances entre les membres*, *Collaboration avec d'autres équipes*, *Collaboration* et *Communication ouverte* devraient être réexaminés et ajustés dans le questionnaire d'évaluation.

Dans le questionnaire, l'ordre des éléments *Partage d'objectifs*, *Partage de valeurs* et *Partage de sens*, qui montrent des corrélations modérées à fortes dans leurs évaluations, devrait être repensé. Ces éléments peuvent entraîner une confusion ou une fatigue chez les répondants et des ajustements sont donc nécessaires pour améliorer leur clarté.

Concernant les questions liées aux éléments de la dimension *Liens externes*, les répondants peuvent rencontrer des difficultés à déterminer quels liens prendre en compte dans leur évaluation. Une solution pourrait consister à ce que les entreprises définissent au préalable les "autres équipes et départements" pertinents, afin d'orienter les répondants dans le processus d'évaluation.

De plus, 2 éléments particulièrement stratégiques pour les démarches d'AC se sont démarqués dans les résultats : *Résolution participative des problèmes* et *Suivi des performances entre les membres*. Bien que régulièrement faiblement notés par les répondants, ces éléments jouent un rôle central dans l'instauration d'une culture d'amélioration continue. Les entreprises souhaitant renforcer la maturité de leurs équipes devraient mettre en œuvre des actions pour développer ces éléments.

Autres contributions du questionnaire :

Les questions ouvertes (optionnelles) sur les suggestions d'amélioration des éléments de maturité ont recueilli un total de 208 réponses, témoignant de l'intérêt des répondants à partager leurs points de vue. L'objectif de l'approche de maturité étant d'inciter les équipes à réfléchir à leur propre maturité et à s'engager activement dans ce processus, il est notable que certaines suggestions portaient sur des réflexions personnelles des membres, tant sur les changements à opérer dans leur propre posture ou comportement que sur ceux à envisager collectivement au sein de l'équipe. Parmi ces propositions, figurent notamment le renforcement de la cohésion, l'intensification des échanges et une collaboration accrue entre les membres. De plus, certaines suggestions formulées par les répondants semblent pertinentes pour la mise en place de plans d'amélioration concrets, telles que l'affichage des données de production du jour précédent.

L'évaluation de la maturité par l'autoévaluation individuelle de tous les membres a permis de recueillir des perspectives variées et d'inclure chacun dans le processus. Globalement, l'approche de maturité

d'équipe vise à engager les équipes dans une dynamique d'AC. Ainsi, sur la base des résultats de maturité, les entreprises peuvent identifier les éléments de maturité à renforcer et définir des actions pour les améliorer. Ensuite, un calendrier peut être établi, suivi d'une réévaluation pour mesurer les progrès des équipes. Ce processus permet également d'évaluer l'impact réel des actions sur les éléments de maturité, ce qui ne peut être entièrement déterminé ni par la littérature, ni uniquement par les perceptions des membres de l'équipe.

En raison des contraintes de temps, la mise en œuvre complète du CTMIP n'a pas pu être réalisée. Toutefois, les retours des 2 entreprises étudiées ont confirmé la pertinence de l'évaluation de la maturité pour soutenir leurs démarches d'AC. L'entreprise E2, en particulier, a directement exprimé un intérêt pour passer à une phase suivante visant à développer un plan d'amélioration en collaboration avec l'équipe de recherche. Ces résultats soulignent le potentiel de l'approche pour soutenir concrètement les programmes d'AC.

Conclusion générale et perspectives

Les défis persistants liés à la pérennité des programmes d'AC sont souvent attribués à des facteurs humains. Cependant, ces défis ne reflètent pas un manque de potentiel humain au sein de ces programmes, mais plutôt une absence de conditions favorables au développement de leur engagement.

Cette thèse vise à contribuer aux dynamiques de progrès au sein des organisations dans le contexte de l'AC, où les collaborateurs représentent le moteur principal de l'amélioration. Pour ce faire, cette étude propose une approche pragmatique et centrée sur l'humain, fondée sur le concept de maturité des équipes.

En effet, une méthode structurée d'évaluation de la maturité des équipes constitue un outil pratique pour soutenir les programmes d'AC, avec l'objectif d'intégrer les équipes de terrain dans cette dynamique. Cette recherche repose sur une étude bibliographique approfondie, qui a permis de développer un modèle de maturité des équipes. Sur cette base, des travaux de terrain ont été réalisés pour valider et affiner cette approche. Bien que ces contributions représentent une avancée significative, elles mettent également en lumière le caractère encore émergent de ces travaux.

Certaines limites méritent d'être soulignées, car elles ouvrent des perspectives pour orienter les efforts futurs visant à affiner et à enrichir cette approche.

Bien que reposant sur une base théorique solide consolidant diverses sources pour garantir une caractérisation complète et adaptée au contexte de l'AC, les éléments de maturité peuvent ne pas refléter pleinement toutes les équipes et les nuances des différents contextes d'AC. En effet, un domaine aussi vaste que l'AC rend difficile l'élaboration d'une caractérisation universelle. Dans cette optique, les études futures pourraient élargir l'exploration de la maturité des équipes. De plus, les retours des équipes seraient précieux pour affiner le modèle de maturité d'équipe, ce qui pourrait être complété par la réalisation de nouvelles études de cas.

En ce sens, les contraintes de temps ont limité la portée des études de cas menées et n'ont pas permis de tester un aspect essentiel : la mise en œuvre d'actions d'amélioration et les réévaluations pour mesurer leur impact sur la maturité. Obtenir des résultats mesurables suite à l'implémentation de ces actions nécessite de laisser du temps aux équipes (probablement plusieurs mois), d'où la nécessité d'études longitudinales pour évaluer l'impact à long terme de l'approche.

La recherche pourrait également bénéficier d'une exploration approfondie des relations entre la maturité individuelle et la maturité d'équipe, afin de mieux comprendre comment les attributs individuels influencent les dynamiques d'équipe et la performance collective, et vice-versa. Cette approche permettrait également une intégration plus précise de la maturité individuelle dans le CTMIP, offrant ainsi une vision plus complète de l'aspect humain dans les initiatives d'AC.

Résumé : La réussite des projets d'amélioration continue (AC) dépend fortement des acteurs humains, de leur engagement face au changement, et de leur implication dans ces projets. Par ailleurs, cette amélioration est souvent initiée et mise en œuvre par les acteurs de terrain eux-mêmes. Cependant, malgré l'importante littérature sur les méthodologies d'AC, assez peu de recherches se sont concentrées sur leurs contributions, pourtant essentielles à la pérennité de ces projets. Ce manque de travaux est particulièrement vrai en ce qui concerne à la fois l'évaluation des dynamiques d'équipes, et l'intégration du facteur humain au-delà des compétences techniques. Cette thèse propose une approche conceptuelle et pratique pour intégrer les acteurs de terrain dans la dynamique de l'AC, à travers un processus d'évaluation et d'amélioration de la maturité des équipes. La maturité d'équipe constitue le fondement de cette approche. En effet, l'équipe joue un rôle central dans les projets d'amélioration et la maturité permet de tenir compte de l'influence réciproque entre les individus, les équipes et leur environnement. Pour étudier cette maturité, il est important d'identifier les caractéristiques des équipes de production matures dans le contexte de l'AC. En s'appuyant sur des publications issues de plusieurs disciplines (domaines du développement de groupe et de l'AC), ainsi que sur des experts terrain de l'AC, cette thèse propose une caractérisation de la maturité d'équipe, composée de 5 dimensions, structurant 16 éléments de maturité. À partir de cette identification, un processus conceptuel d'amélioration de la maturité d'équipe (CTMIP) est proposé, incluant une boucle d'évaluation et d'amélioration. Le développement d'un modèle de maturité et d'un questionnaire d'auto-évaluation permet d'obtenir une mesure de cette maturité d'équipe. Enfin, 3 axes d'intervention et 11 facteurs influençant la maturité sont identifiés pour guider l'élaboration de plans d'amélioration personnalisés. L'approche proposée a été testée sur le terrain à travers des études de cas au sein de 13 équipes de production. Cela a permis de valider la faisabilité de l'évaluation et de confirmer son intérêt pratique en soutien aux initiatives d'AC et à l'intégration des équipes dans un cycle d'amélioration.

Mots clés : amélioration continue, maturité d'équipe, caractérisation de la maturité, évaluation de la maturité, dynamique de progrès, approche centrée sur l'humain.

Abstract: Continuous Improvement (CI) initiatives rely on an engaged workforce to embrace change and adopt its methods, fulfilling both the roles of source and driver to sustain progress. Yet, despite the extensive body of knowledge surrounding CI methodologies, limited research has focused on the workforce contributions essential to sustaining these programs. This lack of research is particularly evident in the absence of systematic assessments that capture team dynamics, or approaches that extend beyond technical skills and knowledge to grasp a more holistic view of the human factor. To bridge this gap, this thesis aims to develop a conceptual and practical approach to embed the workforce into the CI dynamic through the assessment and improvement of team maturity. This approach is based on team maturity, considering the pivotal role teams hold in initiatives, and the broader implications of maturity, not limited to actions, but also encompassing the reciprocal influence among individuals, teams, organizations, and their surrounding environment. To effectively study team maturity, identifying the characteristics of mature production teams within the CI context enables team maturity to be assessed and further improved. Based on research from various fields - group development and CI domains - and CI expert opinion, this thesis proposes a characterization of team maturity composed of 5 dimensions structuring 16 maturity elements. Building on this identification, a Conceptual Team Maturity Improvement Process (CTMIP) is introduced, encompassing a loop of assessment and improvement. Team maturity assessment is proposed through the development of a team maturity model and an assessment questionnaire, offering a practical tool to measure team maturity. This questionnaire is designed for members' self-evaluation of their team's maturity. Concerning team maturity improvement, 3 axes of intervention and 11 team maturity influencers are outlined to assist organizations and guide the design of tailored improvement plans. The team maturity approach is analyzed through case studies - featuring 13 production teams - that confirm the feasibility of the assessment and potential to integrate teams into an improvement dynamic and support CI initiatives.

Keywords: continuous improvement, team maturity, maturity characterization, maturity assessment, improvement dynamic, human-centered approach.