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Processes-oriented maturity framework for Lean  
Manufacturing with health-at-work and performance  
management objectives

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### **Abstract**

Lean Manufacturing is recognised as an approach that improves companies' performance through the elimination of non-value-added activities. However, not all companies implement this approach since there is no standard method for doing so, and some authors have even identified it as a source of stress or occupational illnesses. In light of this, how can an action plan, for its implementation, be defined while guaranteeing the synergy between industrial performance and health at work? Maturity frameworks are tools that identify a company's level of capability regarding the studied parameters, and so can serve as a guide in their organisational transformation. In this article we propose a process-oriented maturity framework for Lean Manufacturing transformation that considers health at work and the company's managerial and operational performance. The framework is illustrated through a company's evolution over the course of a 5-year project, and is then discussed.

**Keywords:** Health at work, industrial performance, maturity, organisational transformation, capability, Lean Manufacturing

## **1 Introduction**

Since its appearance at Toyota (TPS - Toyota Production System) and its popularisation in [Womack et al., 1990], Lean Manufacturing (LM) has been regarded as an approach that improves the performance of a company's production system. It can be applied to companies of different sizes and sectors [De Oliveira et al., 2019], allowing them to adapt to the constant changes in the market

and to requirements in terms of quality, flexibility and responsiveness [Bhamu and Sangwan, 2014].

LM supports continuous improvement of the system by focusing on increasing added value and eliminating wastes [Ohno, 1988]. However, many studies point out that the **implementation of the Lean approach** through these practices and tools **attains varying levels of success** [Almomani et al., 2014], [Hallam and Keating, 2014], [Bhasin, 2011] **and not necessarily sustainable over time**. The gap in success or even failure of LM implementation is often attributed to the lack of standard LM implementation processes or framework [Bhamu and Sangwan, 2014], human factors [Barouch and Kleinhans, 2015] (e.g. due to a poor understanding of the approach or to the resistance to change) and the lack of a Lean corporate culture [Hallam and Keating, 2014], [Nightingale and Srinivasan, 2011]. In this study we are mainly interested in the first two factors.

Concerning a standard LM implementation process, one of the difficulties in defining it is the fact that companies do not have the same levels of functional organisation, formalisation of procedures, work organisation, etc. It is therefore difficult to define an implementation process that will be taken up most companies. [Moeuf et al., 2016] highlight these obstacles to LM implementation in the case of SMEs. As a result, many companies start Lean implementation by applying Lean practices (or 'quick win' tools) throughout the company, only to realise later that the results are not sustainable [Bhasin and Burcher, 2006].

To better take into account the organisational and managerial differences between companies, another way of understanding LM implementation is by using a **maturity model or framework**. Maturity models are used to assess a company's level in relation to the associated parameters and to guide it in defining its evolution with a view to developing sustainable capabilities over time. The maturity model was defined in [Becker et al., 2009] as a conceptual model that consists of a sequence of discrete maturity levels for a class of processes in one or more business domains, and represents an anticipated, desired, or typical evolutionary path for these processes. The Lean Maturity model or framework has been the subject of several recent studies [Jørgensen et al., 2007], [Tortorella et al., 2017], [Zanon et al., 2020]. However the parameters of the models are often Lean practices and tools, which are difficult to use as a guide for the implementation of a Lean transformation process. **For this reason, we argue that the maturity framework should be**

**process-oriented, with the aim of integrating the parameters of the framework into one of the company's processes so that they can be managed and followed up. Thus, the company's processes will be modified (or new ones will be implemented) in accordance with the LM approach and in a sustainable way.** [Koch et al., 2012] highlight the fact that when the Lean approach is introduced into a company, managers must be aware that results are the consequence of processes.

Furthermore, and to return to the second factor of interest to us, it is necessary for human aspects to be considered in the parameters of the framework. Since the 2000s, some authors have identified the implementation of the LM as a generator of stress [Jackson and Mullarkey, 2000], [Conti et al., 2006], or even occupational diseases [Fairris and Brenner, 2001], [Valeyre et al., 2009]. Others have found that, on the contrary, the Lean approach takes health at work into account [Joseph, 2003], [Vinodh et al., 2011]. A systematic correlation between the two factors has not been demonstrated, but it is possible that an inappropriate implementation of LM may lead to poorer working conditions and thus a negative impact on employees' health [Hasle, 2014], [Hamja et al., 2019]. The literature review performed in [Arezes et al., 2015] concludes that "there is no consensus on how Lean principles affect the workplace ergonomics since most authors found positive (advantages) and negative (disadvantages) impacts". It is therefore important to ensure that the Lean transformation of the company ensures health, safety and good working conditions for employees and the maintenance, and improvement of human capital [Machado et al., 2017]. Accordingly, a holistic view of the LM implementation process is necessary not only to improve machinery and equipment, but also to involve human resources [Tortorella et al., 2017], [Bocquet et al., 2019]. **We therefore posit that work organisation and sharing / collaborative processes have an influence on health at work and on the sustainability of results.**

To tackle these issues, this paper proposes **a process-oriented framework to assess the process maturity from the Lean Manufacturing implementation perspective and integrating human health factors.** **The framework<sup>1</sup> identifies the relevant parameters related to the**

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<sup>1</sup>According to [Porter, 1991], frameworks identify the set of relevant variables (related to the topic under study). It helps the analyst to better think through the problem by understanding the company and its environment. The theory embodied in frameworks is contained in the choice of included variables, the way variables are organised, the interactions among the variables, and the way in which alternate patterns of variables and company choices affect

implementation of LM approach including health at work. The contributions are twofold:

- We provide a framework which allows companies to evaluate their initial situation to implement a LM approach. This framework then becomes a guide for them to define the priorities of process transformation and so its Lean implementation path.
- This framework ensures respect for good working conditions in the Lean transformation process, integrating parameters for the development of human capital, and taking into account practices such as ergonomics and ergomotivity to guarantee health at work.

The proposed framework is the result of a combination of bibliographical research and one of the author's involvement in several continuous improvement projects as a consultant in various industrial companies since 2008. These projects lasted between three and five years each, with companies of different sizes, different initial situations (in terms of economic context or internal occupational health), in different industries and so on. This method enabled us first to formalise a framework then to apply it. In this article we present a case study of the application of the maturity framework.

The paper is structured as follows. Section 2 briefly presents a review of the maturity models and frameworks from a LM perspective. In Section 3 the work methodology/research design is introduced. The proposed process-oriented maturity framework is then explained in Section 4. An example of the application of the proposed framework and its results in an industrial company is set out in Section 5, with a discussion on the applicability in other industrial companies. Finally, conclusions and research perspectives are discussed in Section 6.

## 2 Maturity model background

### 2.1 Generalities

The first maturity model, the Capability Maturity Model (CMM), was proposed by Watts Humphrey in the late 1980s to assess companies' capability in software engineering [Yi et al., 2018]. It was 

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outcomes. The frameworks should help the analyst to better think through the problem by understanding the firm and its environment.

gradually extended to the Capability Maturity Model Integration (CMMI) version, which has been applied to several domains [Ngai et al., 2013].

Since then, numerous maturity models have been proposed in various domains, such as risk management in complex projects [Yeo and Ren, 2009], supply chain activities [Reyes and Giachetti, 2010], and product life cycle management [Vezzetti et al., 2014]. These models are seen as means of improving companies' skills in a specific area, as the sequence of levels and the requirements for moving from one to the next allow companies to define objectives and practices that gradually lead them towards performance excellence [Machado et al., 2017], [Looy et al., 2014]. According to [Tesmer et al., 2011], maturity models help companies to prioritise actions and define the type of improvement or "maturity" they need. In the CMM, the maturity of a practice is defined as the degree of process effectiveness and efficiency that reflects the capability of organisations to execute processes successfully [Kaner and Karni, 2004].

Some authors have developed other maturity models, in particular based on organisational capabilities. In [St-Amant and Renard, 2004], organisational capabilities are defined as “the deployment, the combination and the coordination of resources, competencies and knowledge through different value flows to achieve strategic objectives”. It is the potential that a company has to be efficient. Moreover, organisational capabilities are considered as not being static; they can evolve along with their application and so are linked to learning.

[St-Amant and Renard, 2004] therefore propose a maturity model of organisational capabilities, which they define as “a descriptive and normative model of maturity levels through which the organisational capabilities of an organisation will go, as the organisation develops a structured and organised reflection on its operational modes by using and creating knowledge, by improving competencies of its individuals and by investing in resources”. This model is used to assess, both quantitatively and qualitatively, the characteristics of an organisational capacity on a five-level scale, which has similarities with the five levels proposed in CMMI [Ngai et al., 2013]:

- **Level 1 (initial):** corresponds to an *ad hoc* and chaotic organisational capacity, expressed in the performance of activities; processes are not clearly defined. The success of the application depends almost exclusively on individuals' efforts and competencies.

- **Level 2** (description): corresponds to an organisational capacity, expressed and operated with defined and documented processes. This first systematisation improves the efforts, the competencies and the knowledge of individuals and of the organisation.
- **Level 3** (definition): establishes the foundations from which the company will be able to work on improving its organisational capacities and maturity. The organisation has to allow for the repetition of processes and practices that have already been successful. Nevertheless, the processes are not measurable with precision and are only partially controlled.
- **Level 4** (management): refers to a managed organisational capacity. The organisation identifies the competencies, knowledge and best practices, and integrates them into its action processes. The practices are documented and their results are quantitatively controlled and measured. The organisation manages its organisational capacities according to the data it has collected to evaluate its performance. When a process is quantitatively understood and controlled, it becomes predictable. At this level, standards and norms can be established and applied.
- **Level 5** (optimisation): this is the level for optimisation and growth. It is based on a continuous improvement process that is facilitated by the feedback linked to the quantitative and qualitative control of key management processes. The organisational capacity is completely controlled at this level.

Most of the research works (cf. Section 2.2) on maturity models considers 5 levels of maturity very similar to those proposed by [St-Amant and Renard, 2004], with a description adapted to the field under study.

## 2.2 Lean Maturity Models

In the field of LM the number of studies proposing maturity models and frameworks has increased in recent years. Some of them aim at assessing the leanness of the company, others associate LM practices with other practices or approaches.

[Bento and Tontini, 2019] assess the Lean maturity of 90 Brazilian manufacturing companies, considering 38 Lean practices and five levels of maturity. They sent questionnaires to managers involved in the production, continuous improvement or quality activities of these companies. The study does not claim to guide companies in the implementation of Lean; it simply identifies practices with the highest (Customer Focus) and lowest (Problem Solving and Supplier Integration) level of maturity.

Some authors maintain that the Lean Enterprise Self-Assessment Tool (LESAT), developed by Lean Aerospace Initiative (LAI) at the Massachusetts Institute of Technology, is one of the most comprehensive framework [Hallam and Keating, 2014], [Maasouman and Demirli, 2016]. It takes into account 54 Lean Management practices, and for each of them a set of definitions is presented for every level of Lean enterprise maturity. These practices concerns different departments of a company (product development, production, supply chain, etc.) and different control levels (strategic, tactic and operational). Through this framework companies can decide which practices are worth developing to achieve more leanness, but it is not Lean Manufacturing oriented.

[Maasouman and Demirli, 2016] state that most of the maturity models provide a general direction and a company-wide roadmap and fail to monitor the effectiveness of Lean practices. They therefore propose a framework to assess the Lean maturity model adapted to the specifications of manufacturing cells. However, these authors point out that the organisation must provide an overall corporate Lean transformation plan as a prerequisite for the use of the proposed model.

Considering models combining Lean practices with other perspectives, based on a literature review, [Zanon et al., 2020] develop a framework for assessing Lean and Performance Measurement System (PMS) maturity in organisations to take advantage of combined improvement efforts. They reviewed 20 Lean maturity models and 8 Performance Measurement System maturity models and correlated the parameters of both types of models. They found that none of the 35 parameters associated with Lean practices takes into account the working conditions of employees or health at work.

Adopting the same type of approach of reviewing the parameters of the maturity models in the literature, [Tortorella et al., 2017] propose an assessment method that combines LM practices

and social-technical and ergonomics (SE) practices. According to these authors, the method allows for the identification of deficiencies related to the adoption of LM practices that may support the implementation of SE practices. Like [Zanon et al., 2020], [Tortorella et al., 2017] do not consider the process in which the practices are embedded or in which they are intended to be implemented.

## 2.3 Synthesis

We note that the maturity models and frameworks proposed (except for [Bento and Tontini, 2019]) aim to identify the level of mastery in the implementation of the LM, and to highlight opportunities for improvement. These models are based on Lean Management and Lean Manufacturing practices. However, these practices are embedded in the company's processes. In our opinion, and based on the CMMI, it is the ability to execute processes successfully while integrating LM practices that determines a maturity level. It is therefore important that the framework be process-oriented. **It means that the framework parameters should integrate one of the company's processes to be managed, followed up and improved, if necessary.**

We also believe that it is important to integrate indicators (related to the process control and / or to performance) into the maturity model to guide managers more effectively in the use of the framework, to better track the organisational transformation, and to improve the progress process.

Finally, we believe it is also necessary to explicitly consider health at work in the implementation of LM in order to improve working conditions and develop employees' capabilities.

We therefore propose a process-oriented framework to assess processes' maturity from a LM implementation perspective and integrating human parameters, mainly those related to health. Some models from the literature have inspired us in the development of our framework, as we will see in section 4.

## 3 Research methodology

As stated in the introduction, the proposed framework is based on the combination of results of numerous industrial continuous improvement projects and bibliographic research.

The first author of this research paper is a senior consultant with 20 years' experience. He developed his knowledge and expertise initially from ergonomics to health at work, then lean manufacturing and industrial performance in recent years. The research reported here was carried out over a period of 10 years, from 2008 to 2017.

It included nine industrial companies, with on-site production lines and of different sizes (from 350 to 3,000 employees), different initial situations (in terms of economics and LM background or internal health-at-work situations), and different industrial segments (agri-food, automotive, energy, electronic, etc.). In all cases, the cited author was the project leader and steered them. These projects lasted between three and five years.

We can identify two main stages in our research methodology, in two specific groups of companies (Figure 1):

- an inductive stage: initially, we used a first set of observations based on the author's experience and compare these phenomena with a current bibliographic synthesis, to establish a first framework. This framework was tested on three LM projects to propose improvements based on new findings. This stage allowed us to formalise a second maturity framework and to test it on the ongoing LM projects
- a deductive stage: we applied the maturity framework defined in the previous stage to six other industrial companies. The management of these LM projects allowed us to test the proposed hypotheses and to make some local improvements, for instance in the definition of some parameters and their instantiation on the different maturity levels.

This complete approach allowed the proposed maturity framework to evolve, up to the last version that is presented in the next section.

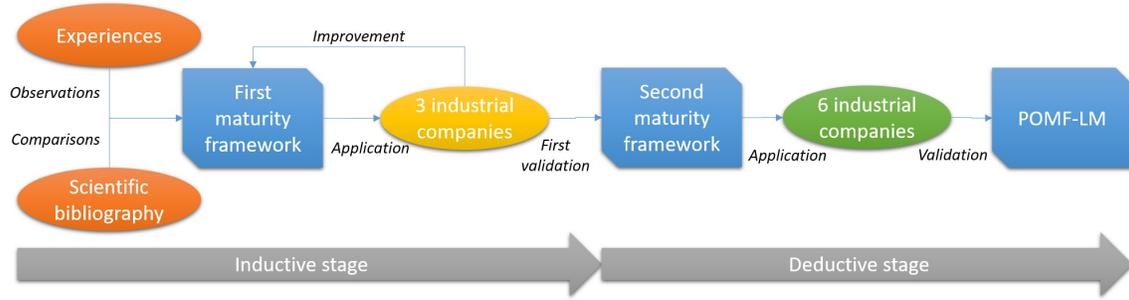


Figure 1: Research methodology description.

## 4 Processes-oriented maturity framework for Lean Manufacturing (POMF-LM)

The first and main objective of the proposed maturity framework, POMF-LM, is to be a tool which allows a manager (e.g. the person responsible for the deployment of the Lean Manufacturing approach) to assess, at a given moment, the company’s capacities and capabilities to implement, execute and control a set of processes necessary to create human, financial and social value in a sustainable way. The second objective of this framework is to serve as a guide for defining an action plan for an improvement project in a Lean Manufacturing context.

POMF-LM is composed of the parameters and of maturity levels considered. For each parameter, the expected process control is described for each maturity level. The maturity levels consider the intention (willingness to do it), awareness (knowing what to do) and know-how (competence) of the company. Thus, for each combination of parameter - maturity level, indicators are proposed, so that the company can verify its level of maturity. These indicators are related to the company’s process control (PCI) and performance (KPI).

In this section we present the different levels of maturity considered in POMF-LM as well as its parameters and their overall evolution in terms of maturity. By means of an example of a parameter, we illustrate its description for each maturity level, as well as the associated indicators. The entire framework is given in Tables 4 to 12.

## 4.1 Maturity framework levels

We propose a maturity framework with 6 levels that determines the improvement stages that an organisation has to follow. We draw on the research of [St-Amant and Renard, 2004] on maturity in organisational capacity, correlated with our own experience. We first add a level 0, which indicates that the company is not aware of what it does and has neither the knowledge nor the method to act and to improve. The company only reacts to intrinsic and extrinsic phenomena, thanks to the will and the motivation of some leaders but without capitalisation, and with a strong risk of loss of impetus and of acquired knowledge.

The different levels can be associated with a process of change management:

- Level 0: **state of unawareness**, since no knowledge or method is implemented, the actions are based on individual efforts; [there is no process defined](#).
- Level 1: **change of perception**, acquisition of knowledge and methods concerning parameters management; [the process has not yet been defined but the parameter is taken into account](#).
- Level 2: **change the way of thinking**, acquired knowledge is applied, enabling the development of know-how; [the process is defined but not completely controlled](#).
- Level 3: **change of behaviour**, the formalisation of the processes allows the reproduction of improvement actions; [the process is defined and controlled](#).
- Level 4: **new habits**, as the processes are totally under control, well documented and improved, naturally reproducible and controlled work habits are established, the approach is spread over the different sectors of the company; [the process is implemented in most of the company's departments](#).
- Level 5: **cultural change**, total and collective appropriation of continuous improvement process; [pursuit of perfection](#).

In the next section, all framework parameters are presented.

## 4.2 Maturity framework parameters

In this section we present the 19 parameters of POMF-LM. They are structured into 4 main processes as shown in Figure 2. These parameters represent sub-processes that has to be performed periodically to ensure a successful implementation of the main processes.

These 4 main processes and their associated parameters have been defined from our industrial experience and literature review (cf. Section 3) as being the crucial elements to enable successful implementation of Lean with respect to health at work. The purpose here is not to present the description of each parameter for each maturity level (an example of instantiation of a parameter will be presented in the following and the whole framework is available in Tables 4 to 12), but to explain why we take it into account in the proposed framework and the expected evolution through this parameter.

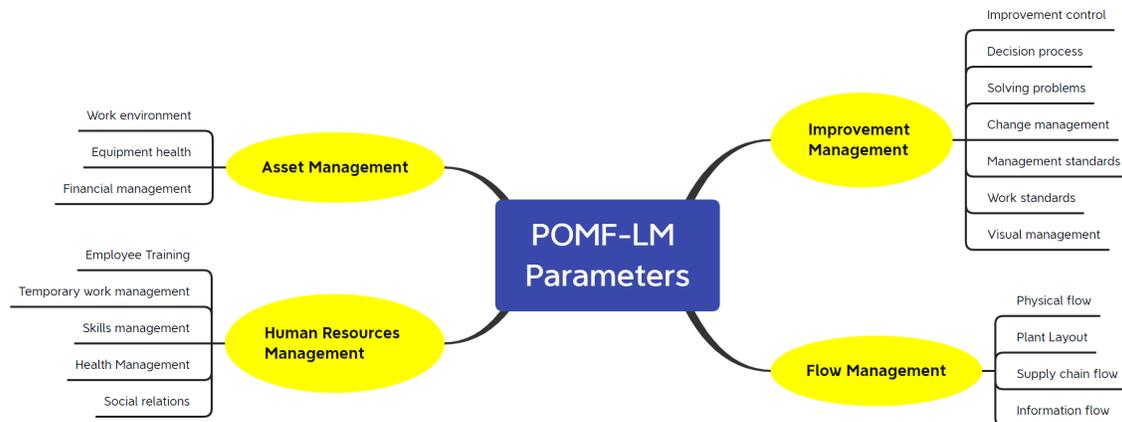


Figure 2: The 19 process-oriented parameters of POMF-LM.

The proposed parameters have been compared afterwards with Lean and SE practices listed in [Zanon et al., 2020] (Table 2) and in [Tortorella et al., 2017] (Table 3). From this analysis, we can conclude that our framework covers all listed practices and we went further by defining these parameters for all maturity levels with consistent indicators.

### 4.2.1 Improvement Management

The first **main process** groups together the **parameters** necessary to implement continuous improvement management in a sustainable way.

**Improvement control** (Table 4): within the proposed framework we define the steps required for a company to control an improvement management process, which at its more mature stage involves a strategic plan, at the tactical and operational levels. This plan must include all the company's departments and must be steered to guarantee the coordination of improvement actions (the setting up of a steering committee is part of a level of maturity). Authors such as [Kaplan and Norton, 2005], [Hines et al., 2004], [Lewis et al., 2006] and [van Assen, 2018] stress the importance of defining a strategic improvement plan to clearly and simply link improvement initiatives to expected results. The Strategic Improvement Plan ensures consistency of actions linking long-, medium- and short-term actions to the results achieved at the organisational level [Neely et al., 1997], [Bourne et al., 2000].

**Decision process** (Table 4): this process is strongly linked to the previous one. It helps to define the decision-making structure of the company. It must ensure that decisions are based on the definition of precise objectives, the identification of decision variables, constraints and criteria to be optimised at the different decision levels. It must also ensure that the objectives of different decision levels are consistent with one another. Thus, it will allow the transmission of the improvement strategy from the general management to the departments, then to different operators, through action plans and quantifiable objectives within a realistic time frame [Liker, 2004], [Bhasin, 2012]. Moreover, and by acquiring more maturity, organisations can reverse the leadership pyramid and give more autonomy and responsibilities to operators and to proximity management in problem-solving actions.

**Solving problems** (Table 4): this parameter concerns **the control of PDCA (Plan, Do, Control, Act) implementation** in the different management levels of the organisation to create an effective problem-solving dynamism. The research presented in [Bortolotti et al., 2015] shows a relationship between the successful implementation of Lean and the use of problem-solving methods.

**Change management** (Table 5): one of the problems often encountered in the implementation of the LM approach is the resistance to change, especially if the company has failed to implement this approach in the past. To avoid or improve this type of situation, companies need to set up a change management process by defining structured communication on the actions to be taken and the results obtained. The presentation of its actions must be contextualised in relation not only to the overall project, but also to the actions of the employees. [Rouse, 2005] argues that it is essential to have extensive knowledge of the organisational context and a complete understanding of existing systems to be able to transform them. Change management must be progressively implemented in all departments of the company and the improvement steering committee must be involved.

The next three parameters of this family are not processes to be implemented, but practices related to LM **that should be managed in the company**. We decided to integrate them into POMF-LM because we noticed in the projects carried out that companies had difficulties in applying or implementing these practices. We therefore integrated them into the proposed framework so that the managers could apply them gradually, to acquire experience and maturity and thus to ensure that the use of these practices is sustainable.

**Management Standards** (Table 5): it is important to implement management standards to formalise processes, tools and practices related to management activities. Managers must define a rhythm of work and rituals that must be respected, according to their level of responsibility.

**Work Standards** (Table 6): these concern the definition of work methods and rules. The work standards must integrate ergonomotivity, which is developed in the Health Management parameter. It implies a strong decrease of work activity variability, by directly improving quality and process performance and must be known by all operators.

**Visual Management** (Table 6): many companies apply 5S and its visual organisation of work areas, but many do not push visual management far enough. Yet this practice makes it possible to make objectives and priorities clearer, to avoid and identify malfunctions and to achieve results in all departments of the company. Several authors show that the results of a transformation are better when employees focus on specific objectives and when these objectives are perceived as achievable, which demonstrates the value of effective visual management [Sim and Rogers, 2008],

[Wan and Chen, 2009], [Saurin et al., 2011].

#### 4.2.2 Flow Management

This **main process** concerns **the parameters related to** the reorganisation and management of the physical and information flows, essential to the implementation of an efficient manufacturing system.

**Physical Flow** (Table 7): the pushed physical flow must be transformed/changed, considering the value flow, in a pull and synchronised flow, **as recommended by the LM approach**.

**Plant Layout** (Table 7): in parallel to the reorganisation of the physical flow, the layout of the workshop must be reconsidered and the workstations **can** be redesigned. **It is usually necessary to change the layout of the workshop to change the physical flow. Furthermore, in the LM logic, companies must move their physical flow as far as possible towards one-piece flow.** It is furthermore important to consider in the reorganisation(s) of the workshop(s) that the operators must not be physically isolated, to avoid stressful situations in case of problems or risks.

**Supply chain Flow** (Table 8): companies must also consider the evolution of their ecosystem, paying particular attention to their flows both upstream (suppliers) and downstream (distribution network, customers). These flows **will** also become more tense but associated with medium to long-term planning based on a MRP2 (**Material Requirement Planning**) logic to anticipate problems.

**Information Flow** (Table 8): this type of flow is sometimes neglected in the application of the LM approach, yet any decision is based on information. Thus, it is also very important to guarantee that employees have access to the right information, at the right time, and that this information is reliable. In this sense, the information flow must be clarified and structured to avoid unnecessary information loops. Therefore, procedures to ensure the quality of data and information must be introduced.

#### 4.2.3 Human Resources Management

Lean paradigms always consider humans as the centre of any improvement. According to [Liker, 2004], the central position of humans in the Lean philosophy is more than a requirement, it is the key to a Lean enterprise's success. This **main process** takes into account **the parameters related to** this

issue.

**Employee Training** (Table 9): many companies define training in relation to the department that requests it when a requirement is identified. However, it is important to implement a training process which is scheduled in line with the improvement planning, and which includes a follow-up of developed competences. This process must be structured, controlled and involve all departments of the company.

**Temporary Work Management** (Table 9): the organisation must have the same concern about temporary workers. A process that incorporates their training, appropriation of corporate culture and their integration into the improvement process must be defined and controlled.

**Skills Management** (Table 10): this parameter is directly related to the two previous parameters. Companies need to manage skills to be able to develop new ones in line with their improvement plan. It is therefore necessary to identify existing skills in all departments, to identify critical skills to define the skills that needed to be developed, and to manage the evolution of skills over time and in each department.

**Health Management** (Table 10): most companies do not consider their employees' health as a process that needs to be controlled and that can improve their performance. Some companies apply indicators related to occupational illnesses, and often manage employee health on a case-by-case basis. This issue is difficult to address in a LM improvement project. A process to manage it is necessary to identify the most common work-related illnesses in the company, to inform employees (including managers) of the risks of occupational illnesses and accidents and to train them in prevention methods, ergonomics and ergomotivity (performing the right movement in the execution of one's work). This process must also follow the evolution of these illnesses and the working conditions of the employees.

**Social Relations** (Table 10): this parameter makes sense particularly for companies located in countries where trade union actions are relevant, as is the case in France. We propose that the company considers its social partners to foster privileged communication with them concerning the objectives and expected impacts of the changes in the company, and thus to involve them directly in its transformation project. It is important for the social partners to be involved in problem-solving

processes, for example to establish a constructive relationship in the implementation of the LM approach. We could integrate this parameter into other processes such as Change Management and Problem Solving, but the importance of these social partners for the smooth running of a Lean project led us to deal with it in a dedicated process.

#### 4.2.4 Asset Management

This main process concerns the parameters related to the management of company assets.

**Work environment** (Table 11): this process concerns the application of an ergonomic approach. Managers must be trained in ergonomics and apply its rules and principles in the analysis of the arduousness associated with the work performed at each workstation. They will thus be able to make the workstation evolve and to take these aspects into account when the evolution of the whole production system is envisaged.

**Equipment health** (Table 11): this process concerns the management of the effectiveness and the maintenance of workshop equipment. It is about: a) managing then avoiding problems that lead to workstation (or even production line) stoppages; and b) carrying out the first level of maintenance by the operators and setting up a preventive maintenance plan.

**Financial management** (Table 12): in the context of a Lean improvement project, it does not mean implementing all the processes required by the financial department of the company. But it is about implementing a process that, in a first phase, ensures that the company's manufacturing activity generates a positive financial balance, and in a second phase, ensures that the company reinvests in its production system.

### 4.3 Synthesis

All the parameters – presented in this section – will help the company to deploy a necessary process to reach maturity in terms of management, decision-making and performance control. This is important for the successful LM implementation, as the evolving maturity of these parameters is what drives the change, organises the value chain, controls competency and manages resources. All these points will directly or indirectly act on the overall performance, in synergy.

As mentioned above, in POMF-LM, a clear description of maturity is presented for all parameters at each maturity level, as well as for process control indicators (PCI) and certain key performance indicators (KPI), which must be measured to validate the level of maturity. A description of all the parameters for each maturity level is given in Tables 4 to 12.

## 5 Experimentation

As indicated in Section 3, much of our research is based on experimentation in 9 industrial companies, carried out in two different stages of our research methodology. In this section we present the experiment performed in the company “Moulin de la Marche”. It was carried out with the first complete formalisation of the maturity framework as presented here, during the second stage of our methodology.

Our objective is to illustrate the application of the POMF-LM in an LM improvement project. To do so, we present some of the actions implemented during this project, to provide an overview of the means that have allowed the evolution of the company’s maturity. Our intention is not to describe all the actions carried out, nor to justify the action plan in detail.

### 5.1 Use-case description

The studied factory “Moulin de la Marche”, located in the west of France, has 350 employees and produces smoked salmon. It belongs to a food processing industrial group consisting of 60 plants with a total of 10,000 employees. This industry was characterised by low gross profits, high variability in raw material costs and a high degree of work arduousness. The management system and the industrial organisation system were based on the silo principle, meaning that the organisation was divided into workshops (shipping, fillet preparation, smoking, etc.) without any communication or transverse cooperation. Performance measurements were mainly quantitative and carried out per workshop. Finally, problems were solved individually by a quality department which imposes its processes.

This plant was studied and assisted between 2008 and 2013, with the objectives of **increasing**

**its competitiveness and reducing workstation arduousness, to maintain employment sustainably.** The company's economic context changed between 2008 and 2010, with stronger competition and an increase in the cost of raw materials. As far as human resources are concerned, nothing particular happened during this period, except that the population aged and some operators were not able to remain at their workstations for full shifts due to loss of physical capacity.

## 5.2 Evaluation method

The steering committee, consisting of the company's management committee and the head of maintenance, was first trained in all the concepts and principles included in the proposed framework. Note that, in general, **the steering committee should be made up of managers representing the parameter families.** This global training lasted between 6 and 8 days and focused on the main concepts of the POMF-LM. The committee assessed the company's maturity four times during the project (in 2008 - Figure 3, 2010 - Figure 4, 2011 - Figure 5 and 2013 - Figure 6), and was assisted for the first assessment only. The frequency of maturity framework assessments was scheduled according to the stages of the improvement project. An assessment was carried out not only at the beginning of the project but also at each important step of the way, as the project evolved with the company's improvement. More importantly, it certified the implementation of concrete management and control of all processes with PCI and KPI measurements.

Each evaluation was carried out by a duo, to create a constructive and shared dynamic, and to highlight the diversity of perceptions. Each time, each duo of members of the steering committee presented their evaluation. Any shortcomings concerning the different perceptions required argumentation, to reach a global and shared consensus. The advantages of this procedure are as follows:

- it is a way for all members of the steering committee to share their perception based on facts;
- it allows a maturity level to be placed on an improvement scale, thus giving the steering committee a reference point in the progress to be achieved;

- the progress level thus defined creates a process of motivation and the PCIs and KPIs measured help in this sense;
- it highlights the company's strengths and weaknesses, so that the steering committee can define the development strategy more clearly and precisely.

The steering committee carried out all the evaluations during this project, with no changes in membership. The only difference at each stage was in the definition of the duos that could change, for the sake of better information sharing.

### 5.3 Initial situation in 2008 and first proposals

The company's initial situation was assessed and the result is shown in Figure 3. The following paragraphs provide details on the evaluation of certain parameters.

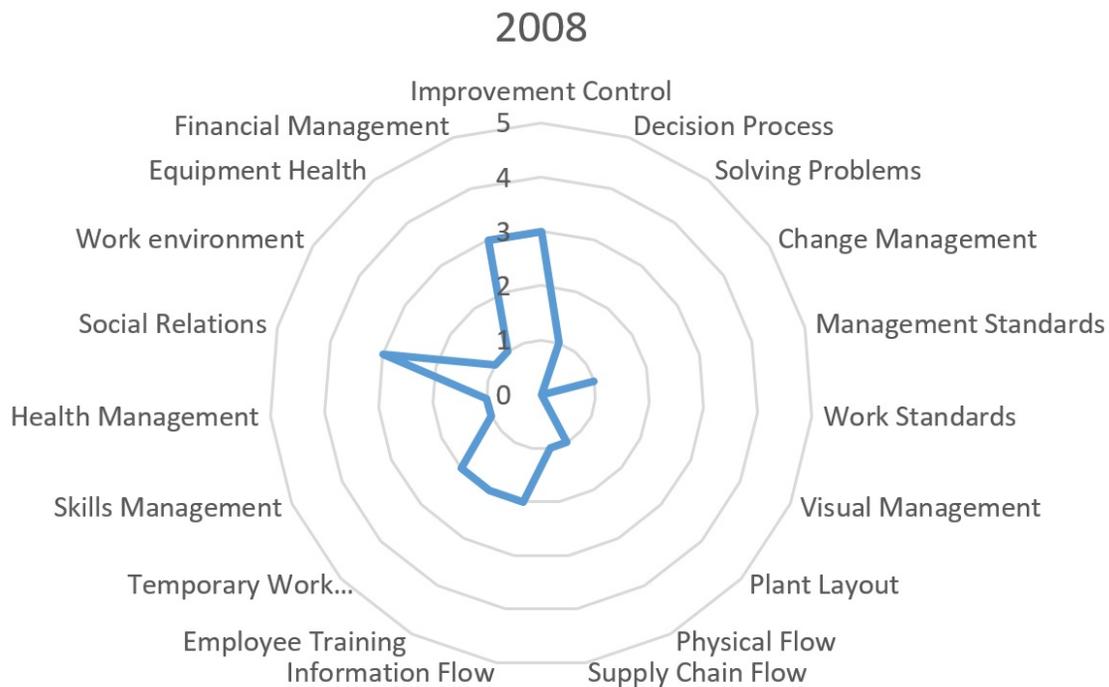


Figure 3: Maturity evaluation in 2008

The maturity level of the "**Work Environment**" parameter was assessed at level 1. Even though the plant had little knowledge of ergonomics, some attempts to improve workstation ergonomics had been made in the past. Unfortunately, these actions did not have a real impact on working conditions, and the need for progress in this area was perceived within the company.

The maturity of the "**Health Management**" parameter was also assessed at level 1. The plant had no knowledge of the Ergomotivity approach, but the need to develop operating modes for each workstation, consistent with the dynamic behaviour of the operators, was already perceived. Moreover, although absenteeism was increasing strongly (since it was also beginning to affect the young population of operators), no causal relationship between absenteeism and the effects of the arduousness of the workstation was identified and, above all, none of the participants had the ability to identify it. At that time, there were no relevant indicators or occupational health management processes that could help managers make this assessment.

The maturity of the "**Work Standards**" parameter was assessed at level 0. There was a high variability in work methods due to uncontrolled work. In addition, the learning processes were long and significant differences in the teaching of working methods were identified. For instance, the morning team developed a fillet preparation method that differed from that of the afternoon team, without any specific reasons. Additionally, some operators on the morning team were declared medically unfit to perform certain operations. During this first audit, the lack of work standards was identified as one of the main causes of production variability and the lack of control over working methods was the main cause of certain physiological constraints.

## 5.4 Project and company maturity evolution

Considering this initial assessment, a large number of actions could have been proposed. However, the company was not ready to implement all of them and its resources were limited. It was therefore decided to focus the project on work standardisation and work environment parameters during the period from 2008 to 2009, and on the improving other parameters from 2009 to 2010. Note that at the beginning of the project, the priority was not to enable the company to carry out a LM improvement project independently (without the help of the consultants), but to get the company

out of a critical situation.

After this decision, the first step was **to identify and validate relevant indicators** relating to the work environment parameter. The manager, responsible for this action, defined indicators of arduousness to manage the employees' physical ageing as well as possible. At that time, there was no one in the company who could evaluate the company with regard to physical risks and the inability of an operator to perform the right gesture at a work situation. The company could only identify the increase in absenteeism, but this would not be enough to understand, measure, correct and above all prevent the causes of this absenteeism.

The performance indicators that were employed were as follows:

- Scaling of workstation arduousness,
- Number of complaints per workstation,
- Number of RSI (Repetitive Strain Injury) reports by workstation,
- Cost related to absenteeism for physical risk,
- Number of near-accident reports,
- Accident severity rate and frequency rate.

The second step was to implement a KPI control process. For instance, the number of complaints, an important indicator that expresses (implicitly) the level and quality of problems mentioned by employees, was difficult to measure. There was nowhere that employees could freely report their physical problems. Therefore, the steering committee decided to create **the position of Head of Infirmary and Prevention**. The missions of this new post were:

- to control health management and work environment indicators,
- to assist employees in situ,
- to support managers,
- to lead ergonomotivity actions and to implement gestural work standards.

The third step concerned the **training of all managers in ergonomics and ergomotivity**. This changed the level of perception and launched the change management process initiated by the steps to improve working conditions. The shipping workshop was one of the first to be transformed, because this workshop really required attention to the operators' gestures and ergonomic aspects.

Finally, **the prevention manager was trained** in ergonomics, ergomotivity, standardisation, and control of indicators. He was then able to apply the training on the principles of ergomotivity by instructing operators. Standardisation actions were thus organised at each workstation in the plant between 2008 and 2009. At the end of this process, each of these workstations had a gesture work standard. In addition, each employee with a physical disability was assisted by the prevention manager.

After these actions, a new assessment was carried out at the end of 2010 to finalise this first phase of the project (Figure 4). Several partial evaluations had been performed the meantime to verify the impacts of the actions.

All the employees were really involved in this evolution; it was a phase of radical change that strongly mobilised all the staff and in particular all levels of management. A large number of workshops and training sessions (also concerning other parameters) were organised. As a result, the overall maturity was greatly improved in all parameters. However, the company still had shortcomings concerning *Improvement Control* and *Solving Problems* (e.g. control of the problem-solving process).

Based on this evaluation, the project priority changed to better organisation of the added value flows, and to improvement of workstation ergonomics and of control process.

At the end of 2011, we noticed a distinct decrease in the company's revenue. In the assessment carried out at that point (Figure 5), the decrease in the indicators of the maturity framework showed that the maturity acquired in 2010 had not lasted. This evaluation motivated the decision to launch investigations to correctly identify the roots of the problem and thus to find solutions. One of the most critical aspects concerned *improvement management* family, in particular *change management*. The audit highlighted the fact that the parameters linked to *improvement management* and *human resources management* significantly decreased its maturity level between 2010 and 2011.

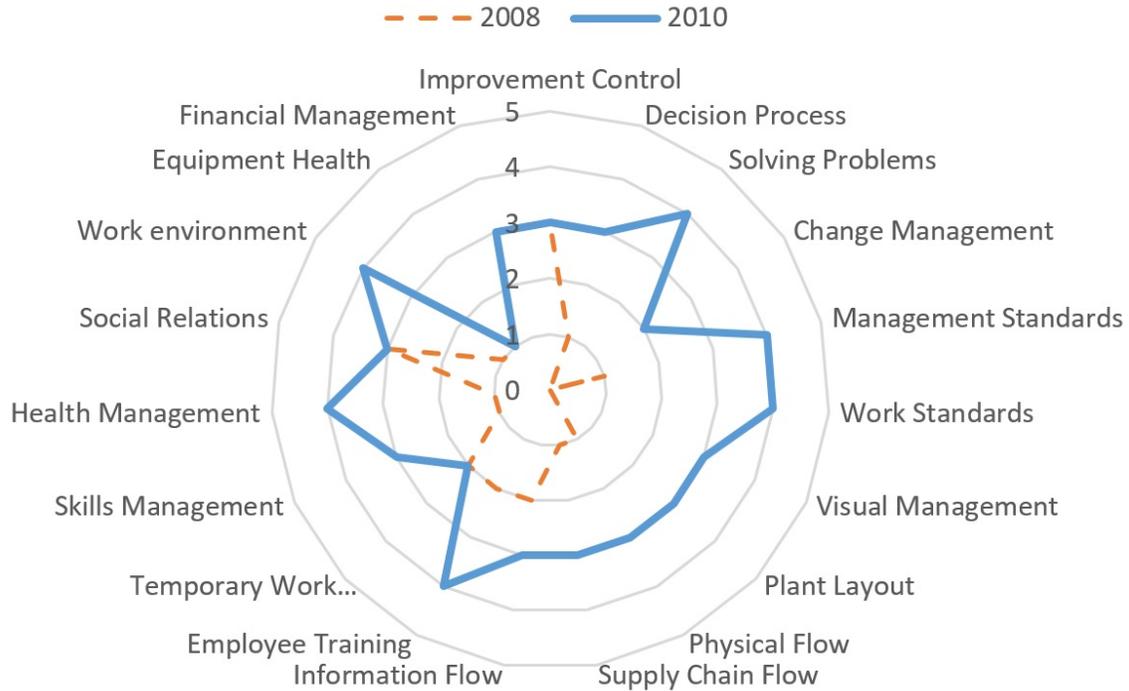


Figure 4: Maturity evaluation at the end of 2010, in comparison with that of 2008.

After studying the problem, the steering committee took the decision to appoint a performance manager to lead the project and to move the improvement control process forward. As a result, two years later (2013) a major improvement was noticed in the *improvement control* process and in *problem solving* parameters through the framework evaluation (Figure 6). Each of the managers had really found his/her place and acquired strong operational skills in problem solving and local management, consistent with the new organisation of physical flows.

In terms of measured performance indicators, the company noted that during the period from 2010 to 2013:

- complaints and absenteeism for RSI (Repetitive Strain Injury) concerning employees under 30 years of age had been eradicated,
- health insurance premiums had been reduced by 50%,



Figure 5: Maturity evaluation at the end of 2011, in comparison with that of 2010.

- the company had generated annual profits of 1,500,000 €,
- the local managers had been boosted by the increase of their competencies and their responsibilities.

The project ended in 2013 with these results. Two years later, we came back in this company and could certify that:

- the improvements made during the project period were still real,
- the periodic maturity assessment was still applied.

These elements justify a sustainable transformation for this company.

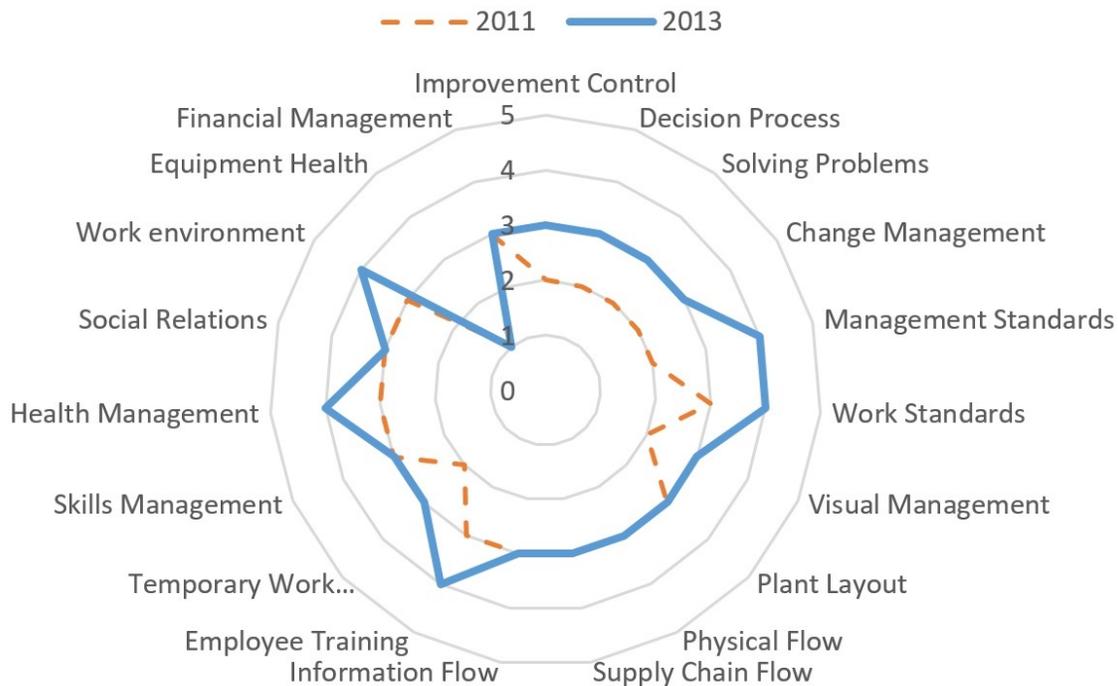


Figure 6: Maturity evaluation in 2013, in comparison with that of 2011.

## 5.5 Discussion

At the end of this project, a closing meeting of the project was organised to present the results and have a feedback from the managers involved. All participants agreed that this tool had contributed to:

- identifying the essential aspects (parameters) that needed to be controlled to carry out an improvement project,
- assessing the company's maturity concerning these parameters,
- guiding the company in defining (or modifying) the action plan.

For the managers involved in the project, the difficult situation experienced in 2011 showed that the proposed framework helps to identify the parameters that are at the origin of the problems encountered in the company, thanks to the measurement of the indicators associated with each

parameter (and therefore their maturity). However, further analysis is needed to identify the root causes. In addition, this situation also demonstrate that the maturity acquired could be lost. Therefore, the use of POMF-LM should be combined with a periodic audit process to be defined in relation to the company, especially its size and available resources.

The progress of the other improvement projects (in other companies - from 2013 to 2017) confirmed the usefulness of the proposed POMF-LM. Among these other companies, we can take the example of “Jean Louis Amiotte”, which is a SME specialised in the Morteau and Montbéliard sausage production (leader of this market). This company had 150 to 240 employees according to seasonality, with a turnover of 40M€. After a 31-months project (between 2015 and 2018), almost all objectives have been reached, like an absenteeism rate that went from 3% to 0.98%.

On the other hand, in the closing meeting, the managers involved have highlighted that the framework helped them to better identify the relations between the proposed parameters in an improvement project, thus enhancing their overall vision of the company.

We noticed that a gain of maturity in a given parameter directly or indirectly impacts understanding of the other(s) parameter(s). For instance, the *improvement control* and *solving problem* parameters are related to all other parameters, the *plant layout* and *physical flow* also have an influence on each other, and so on. Thus, it is advisable to adopt a global approach regarding the evolution of the parameters, to ensure the effectiveness of an LM improvement project, instead of focusing on only a few parameters. A first lesson learned was that there should not be large differences between the maturity levels of parameters, for instance a gap greater than 2 levels between two parameters, to guarantee a dynamic between all the actors involved.

Another lesson learned concerned a limit to the use of the proposed framework. We had found that the company had to reach a certain maturity level to be able to assess its level of maturity itself, without the intervention of an expert or consultant. Based on the experience from all the experiments, the Table 1 shows the minimum maturity level required for each parameter so that a company can assess its own maturity level.

| Parameters Family          | Maturity Level   |
|----------------------------|--|
| Improvement Management     | Level 3 for all parameters   |
| Flow Management            | Level 3 for all parameters   |
| Human Resources Management | Level 1 for Social Relations<br>Level 3 for other parameters           |
| Asset Management           | No required level for Financial Health<br>Level 3 for other parameters |

Table 1: Maturity level required for a company self-evaluation

## 6 Conclusion and further research

In order to simultaneously improve industrial performance and health at work in a context of LM implementation, we have proposed in this article a process-oriented framework for assessing company maturity (POMF-LM). POMF-LM assesses the level of a company’s ability to manage the different processes required to implement a LM improvement project. In addition, the proposed framework can be used as a guide to help managers define improvement actions and control performance. The POMF-LM is composed of 19 parameters divided into 4 families (improvement management, flow management, human resource management and asset management). The parameters are instantiated on 6 levels of maturity.

This framework was first designed to provide a factual measure of the company’s maturity levels. Each level of maturity presents a description of the control level expected for each process, and provides process control indicators and performance indicators to be measured and followed up. In this way, the maturity framework structures and guides the company’s LM transformation. It enables it to identify maturity level gaps between the actual current situation and the objectives, to highlight the sensitive parameters (responsible for these gaps), and to control processes and thus develop performance and health at work. **It is important to note that the maximum maturity level for each parameter has been defined from the perspective of the implementation of the LM approach. Thus, the maximum maturity level is not necessarily ideal for all companies, as some aspects of this approach are not applicable to all contexts. For example, pull flow is difficult to apply to companies that face strong market variations. The most important point is therefore to define the levels of maturity to be reached in accordance with the company’s strategy.**

POMF-LM has been tested, partially or completely, on several companies, in very different contexts in terms of economic strength, industry, size, country, etc. Its use in the context of a company's LM improvement project has demonstrated that a maturity level is not definitively acquired but requires continuous effort. The framework can nevertheless measure possible maturity decreases and guide the problem-solving process. To avoid significant losses of maturity, we recommend periodic use of this tool, **for instance every 6 or 9 months (this subject have been discussed in [Galichet et al., 2015])**. The periodicity must be defined by the steering committee, and according to the size of the company and especially the means to be implemented to carry out these controls.

Concerning future work, we are going to define precedence rules between different levels of parameters. We have seen in Section 5.5, the maturity level of some parameters impacts the maturity progress of others. To guide POMF-LM users more efficiently, we think it is useful to define rules for the evolution of maturity between different parameters (e.g. the parameter P1 must be at maturity level 3 for the company to be able to shift the parameter P2 to level 2).

From a broader perspective, the framework does not define the improvement path. Future research could work on the definition of maturity objectives that are consistent with a company's strategy in terms of overall performance and resource allocation. Our aim is to establish a methodology that defines an improvement path on the basis of the initial and targeted maturity level.

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Comments:

**Value creation** : The increase in value (added or created) being the basis of the lean approach, we consider that it must guide all the company processes

**Lean tools and method** : Only some Lean tools are specified in the proposed framework

**Improvement Approach** : All the parameters of the framework proposed are based on an improvement approach, but it is in the first parameter that this approach is specifically taken into account

**Flexible manpower and cross functional work** : Skills management implicitly aims to develop these qualities

**Product/Process quality planning** : Work standards contribute to product and process quality, without focusing on planning

**Perfection focus** : This is included in the top maturity level of all parameters

**Task-force preparation** : This is implicit in the preparation of the proposed approach, with dedicated training for all stakeholders concerned

**Supplier integration** : As this approach focuses on the core company, suppliers are only taken into account but not included

**Change management and sustainability** : The sustainability of the actions must be taken into account in all parameters

**Overload for achievement of goals** : The mental load is only partially taken into account in this approach, which is more focused on the physical load

**Ergonomics criteria for workstation design** : Only at the top maturity level of this parameter

| Parameters Family                               | Improvement Mgmt.   |                  |                 |              |                 |                | Flow Mgmt.   |              |               |                   | HR Mgmt.         |                   |                      |              | Asset Mgmt.  |                  |                  |                  |                 |
|---|---------------------|------------------|-----------------|--------------|-----------------|----------------|--------------|--------------|---------------|-------------------|------------------|-------------------|----------------------|--------------|--------------|------------------|------------------|------------------|-----------------|
|   | Improvement control | Decision Process | Solving Problem | Change Mgmt. | Mgmt. Standards | Work Standards | Visual Mgmt. | Plant Layout | Physical flow | Supply Chain Flow | Information flow | Employee Training | Temporary work Mgmt. | Skills Mgmt. | Health Mgmt. | Social Relations | Work Environment | Equipment Health | Financial Mgmt. |
| <b>Proposed Parameters</b>                      |                     |                  |                 |              |                 |                |              |              |               |                   |                  |                   |                      |              |              |                  |                  |                  |                 |
| Leadership and management commitment            | ✓                   | ✓                |                 | ✓            |                 |                |              |              |               |                   |                  |                   |                      |              |              |                  |                  |                  |                 |
| Change climate creation                         |                     |                  |                 | ✓            |                 |                |              |              |               |                   |                  |                   |                      |              | I            |                  | I                |                  |                 |
| Customer focus                                  | I                   | I                | I               |              |                 |                |              | I            | I             | I                 | I                | I                 | I                    |              |              |                  |                  | I                |                 |
| Production processes                            |                     |                  |                 |              |                 |                |              | ✓            | ✓             |                   |                  |                   |                      |              |              |                  |                  |                  |                 |
| Value flow identification                       |                     |                  |                 |              |                 |                |              |              | ✓             |                   |                  |                   |                      |              |              |                  |                  |                  |                 |
| Value creation                                  | I                   | I                | I               | I            | I               | I              | I            | I            | I             | I                 | I                | I                 | I                    | I            | I            | I                | I                | I                | I               |
| Lean tools and method                           |                     |                  | ✓               |              | ✓               | ✓              | ✓            |              |               |                   |                  |                   |                      |              |              |                  |                  |                  |                 |
| Maintenance System                              |                     |                  |                 |              |                 |                |              |              |               |                   |                  |                   |                      |              |              |                  |                  | ✓                |                 |
| Problem Solving methods                         |                     |                  | ✓               |              |                 |                |              |              |               |                   |                  |                   |                      |              |              |                  |                  |                  |                 |
| Improvement Approach                            | ✓                   |                  |                 |              |                 |                |              |              |               |                   |                  |                   |                      |              |              |                  |                  |                  |                 |
| Implementation planning                         | ✓                   |                  |                 |              |                 |                |              |              |               |                   |                  |                   |                      |              |              |                  |                  |                  |                 |
| Prioritisation                                  | ✓                   | ✓                |                 |              |                 |                | ✓            |              |               |                   |                  |                   |                      |              |              |                  |                  |                  |                 |
| Flexible manpower and cross functional work     |                     |                  |                 |              |                 |                |              |              |               |                   |                  |                   | I                    |              |              |                  |                  |                  |                 |
| Lean wastes absence                             |                     |                  |                 |              |                 |                |              | I            | I             | I                 | I                |                   |                      |              |              |                  |                  |                  |                 |
| Pull system implementation                      |                     |                  |                 |              |                 |                |              | ✓            | ✓             |                   |                  |                   |                      |              |              |                  |                  |                  |                 |
| Standardised work                               |                     |                  |                 |              |                 | ✓              |              |              |               |                   |                  |                   |                      |              |              |                  |                  |                  |                 |
| Product/Process quality planning                |                     |                  |                 |              |                 | P              |              |              |               |                   |                  |                   |                      |              |              |                  |                  |                  |                 |
| Workplace organisation                          |                     |                  |                 |              |                 |                | ✓            | ✓            |               |                   |                  |                   |                      |              |              |                  | ✓                |                  |                 |
| Perfection focus                                | I                   | I                | I               | I            | I               | I              | I            | I            | I             | I                 | I                | I                 | I                    | I            | I            | I                | I                | I                | I               |
| Task-force preparation                          |                     |                  |                 |              |                 |                |              |              |               |                   |                  | I                 | I                    | I            | I            | I                |                  |                  |                 |
| Vision communication                            |                     |                  |                 | ✓            |                 |                |              |              |               |                   |                  |                   |                      |              |              |                  |                  |                  |                 |
| Goal oriented Teams                             |                     | ✓                |                 |              | I               |                | ✓            |              |               |                   |                  |                   |                      |              |              |                  |                  |                  |                 |
| Supplier integration                            |                     |                  |                 |              |                 |                |              |              |               | P                 |                  |                   |                      |              |              |                  |                  |                  |                 |
| People enabled processes and respect for people |                     |                  |                 | ✓            |                 |                |              |              |               |                   |                  | ✓                 | ✓                    | ✓            | ✓            | ✓                |                  |                  |                 |
| Facilities management                           |                     |                  |                 |              |                 |                |              |              |               |                   |                  |                   |                      |              |              |                  |                  | ✓                |                 |
| Continuous improvement through Lean practices   | I                   | I                | I               | I            | I               | I              | I            | I            | I             | I                 | I                | I                 | I                    | I            | I            | I                | I                | I                | I               |
| Value stream management                         |                     |                  |                 |              |                 |                |              | I            | I             | I                 | I                |                   |                      |              |              |                  |                  |                  |                 |
| Strategy planning and deployment                | ✓                   |                  |                 |              |                 |                |              |              |               |                   |                  |                   |                      |              |              |                  |                  |                  |                 |
| Focus on communication                          |                     |                  |                 | ✓            |                 |                | ✓            |              |               |                   |                  |                   |                      |              |              |                  |                  |                  |                 |
| Six sigma manufacturing                         |                     |                  |                 |              |                 |                |              |              |               |                   |                  |                   |                      |              |              |                  |                  |                  |                 |
| Change management and sustainability            |                     |                  |                 | ✓            |                 |                |              |              |               |                   |                  |                   |                      |              |              |                  |                  |                  |                 |
| Extended enterprise                             |                     |                  |                 |              |                 |                |              |              |               |                   |                  |                   |                      |              |              |                  |                  |                  |                 |
| Zero defects                                    |                     |                  |                 |              |                 |                |              |              |               |                   |                  |                   |                      |              |              |                  |                  |                  |                 |
| Production system design flow                   |                     |                  |                 |              |                 |                |              | ✓            | ✓             |                   | ✓                |                   |                      |              |              |                  |                  |                  |                 |

Table 2: Comparison between parameters from [Zanon et al., 2020] and the POMF-LM ones

| Parameters Family   | Improvement Mgmt.   |                  |                 |              |                 |                | Flow Mgmt.   |              |               |                   | HR Mgmt.         |                   |                      |              | Asset Mgmt.  |                  |                  |                  |                 |
|---|---------------------|------------------|-----------------|--------------|-----------------|----------------|--------------|--------------|---------------|-------------------|------------------|-------------------|----------------------|--------------|--------------|------------------|------------------|------------------|-----------------|
|   | Improvement control | Decision Process | Solving Problem | Change Mgmt. | Mgmt. Standards | Work Standards | Visual Mgmt. | Plant Layout | Physical flow | Supply Chain Flow | Information flow | Employee Training | Temporary work Mgmt. | Skills Mgmt. | Health Mgmt. | Social Relations | Work Environment | Equipment Health | Financial Mgmt. |
| <b>Proposed Parameters</b>                                |                     |                  |                 |              |                 |                |              |              |               |                   |                  |                   |                      |              |              |                  |                  |                  |                 |
| Communication and information system                      |                     |                  |                 | √            |                 |                |              |              |               | √                 |                  |                   |                      |              |              |                  |                  |                  |                 |
| Overload for achievement of goals                         |                     |                  |                 | P            |                 |                |              |              |               |                   |                  |                   |                      |              |              |                  | P                |                  |                 |
| Management of staff turnover                              |                     |                  |                 |              |                 |                |              |              |               |                   | √                | √                 | √                    |              |              |                  |                  |                  |                 |
| Ergonomics criteria for workstation design                |                     |                  |                 |              |                 |                |              |              |               |                   |                  |                   |                      |              |              |                  | √                |                  |                 |
| Workstation appropriated to workers                       |                     |                  |                 |              |                 |                |              |              |               |                   |                  |                   |                      |              |              |                  | √                |                  |                 |
| Workers' recognition and reward                           |                     |                  |                 |              |                 |                |              |              |               |                   |                  |                   |                      | P            |              | P                |                  |                  |                 |
| Teamwork and coaching                                     |                     |                  |                 |              |                 |                |              |              |               |                   | I                | I                 | I                    | I            | I            |                  |                  |                  |                 |
| Clarity in targets definition                             |                     |                  |                 | √            |                 |                | √            |              |               |                   |                  |                   |                      |              |              |                  |                  |                  |                 |
| Risk alerts utilisation                                   |                     |                  |                 |              |                 | √              | √            |              |               |                   |                  |                   |                      |              |              |                  | √                |                  |                 |
| Search for good organisational climate                    |                     |                  |                 | √            |                 |                |              |              |               |                   |                  |                   |                      |              |              |                  |                  |                  |                 |
| Search for the health and safety of workers               |                     |                  |                 |              |                 |                |              |              |               |                   |                  |                   |                      |              | √            |                  | √                |                  |                 |
| Balancing among quality, scope, time and cost             | √                   |                  |                 |              |                 |                |              |              |               |                   |                  |                   |                      |              |              |                  |                  |                  |                 |
| Anticipating and reducing the risk of incidents           |                     |                  |                 |              |                 |                |              |              |               |                   |                  |                   |                      |              | √            |                  | √                |                  |                 |
| Appreciation for workers training                         |                     |                  |                 |              |                 |                |              |              |               |                   | √                | √                 |                      |              |              |                  |                  |                  |                 |
| Ergonomics recommendations as regulations                 |                     |                  |                 |              |                 |                |              |              |               |                   |                  |                   |                      |              |              |                  | √                |                  |                 |
| Clear strategies, symbols and methods                     | √                   |                  |                 |              | √               | √              |              |              |               |                   |                  |                   |                      |              |              |                  |                  |                  |                 |
| Regulation of technical, organisational and human aspects |                     |                  |                 |              |                 |                |              |              |               |                   |                  |                   |                      |              |              | P                | P                |                  |                 |
| Meetings for communication of projects                    |                     |                  |                 | √            |                 |                |              |              |               |                   |                  |                   |                      |              |              |                  |                  |                  |                 |

Table 3: Comparison between Socio-technical and Ergonomic parameters from [Tortorella et al., 2017] and the POMF-LM ones

| Levels              | Level 0: State of un-<br>awareness   | Level 1: Change of<br>perception   | Level 2: Change the<br>way of thinking   | Level 3: Change of<br>behaviour  | Level 4: New habits  | Level 5: Cultural<br>change  |
|---------------------|--|--|--|--|--|--|
|                     | No knowledge nor<br>method implemented   | Acquisition of knowledge<br>and methods concerning<br>parameters management  | Acquired knowledge is<br>applied, enabling the de-<br>velopment of know-how  | the formalisation of the<br>processes allows the re-<br>production of improve-<br>ment actions   | The processes are totally<br>under control, well doc-<br>umented and improved,<br>to that naturally repro-<br>ducible and controlled<br>work habits can be es-<br>tablished  | Total and collective ap-<br>propriation of contin-<br>uous improvement pro-<br>cess  |
|                     | No engaged process, no<br>structure  | Process non defined but<br>parameters taken into<br>account  | Process defined but not<br>completely controlled   | Process defined and con-<br>trolled  | Process is implemented<br>in most company depart-<br>ments   | Perfection is sought   |
| Improvement Control | No implementation<br>of improvement con-<br>trol process. The<br>management is fully<br>conventional | As managers are trained<br>in Lean Management, it<br>generates an awareness<br>of the necessity to inte-<br>grate the Lean approach<br>in the company control.<br>Some improvement ac-<br>tions are implemented,<br>with no coordination | A steering committee for<br>improvement control is<br>implemented. An im-<br>provement plan is de-<br>fined and improvement<br>actions are followed-up | The steering committee<br>is effective since one<br>year, the improvement<br>plan is controlled and<br>improvement actions are<br>coordinated. The results<br>can easily be perceived  | The steering committee<br>concerns all company de-<br>partments and can be<br>mixed up with the exec-<br>utive team  | Management of the com-<br>pany improvement pol-<br>icy is implemented and<br>adapted at each level<br>(strategic, tactical and<br>operational).  |
| Decision Process    | Decisions are strongly<br>centralised, not shared<br>and without framework                           | Managers are trained in<br>the decisional process<br>and its structure. De-<br>cisions are clarified but<br>top-down, without stan-<br>dard process. Some indi-<br>cators exist  | The decision process is<br>implemented from the<br>manager level (within a<br>limited perimeter), but<br>in a conventional way                         | KPI: KPIs related to<br>implemented actions<br>A decision process model<br>is defined based on the<br>concept of an inverted<br>pyramid. An au-<br>tonomous management<br>process is controlled.<br>The results and process<br>indicators are identified | PCI: Deployment of vi-<br>sual management and<br>KPIs from the executive<br>team<br>KPI: KPIs related to<br>implemented actions<br>The decision process is<br>under control and de-<br>ployed for each deci-<br>sion level and depart-<br>ments. Decisions are<br>taken considering indi-<br>cators evolution and in<br>autonomous way (ac-<br>cording to the manage-<br>ment set level)                                   | PCI: Visual manage-<br>ment on all company<br>level; A3 of company<br>policy visible at each<br>level; Result and pro-<br>cess indicators visible<br>and updated<br>KPI: KPIs related to<br>implemented actions<br>The decision process is<br>deployed on all sites of<br>the company. An au-<br>tonomous management<br>set is constituted to<br>control improvement at<br>each site   |
| Solving Problems    | The daily constraints<br>use all resources   | The managers are<br>trained in PDCA and<br>problem solving method  | PDCA is used by man-<br>agers in improvement ac-<br>tivities and in problem<br>solving ones, but not<br>controlled                                     | PCI: Decision process<br>standards formalised;<br>Visual management<br>implemented related to<br>decisions and results   | PCI: Decision process<br>standards formalised for<br>all levels; Visual man-<br>agement implemented<br>related to decisions (for<br>all levels) and its results;<br>Measure of gaps with<br>expected management<br>standards; Number of<br>audits<br>PDCA is used in the<br>daily management of op-<br>erations by all depart-<br>ments (or almost), and<br>used in the annual con-<br>trol of improvement ac-<br>tivities | PCI: Decision process<br>standards formalised for<br>all levels and sites; Vi-<br>sual management imple-<br>mented related to deci-<br>sions (for all levels) and<br>its results; Measure of<br>gaps with expected man-<br>agement standards at all<br>sites; Number of audits<br>at all sites<br>Suggestions from ope-<br>rations strengthen PDCA<br>flows from annual plan<br>at a rate of more than 25<br>per people and per year |
|                     |  | PCI: Number of trained<br>managers   | PCI: PDCA indicators<br>implemented  | PCI: PDCA standard<br>is formalised; Traceabil-<br>ity and capitalisation of<br>problems<br>KPI: Number of prob-<br>lems treated; KPIs re-<br>lated to problems  | PCI and KPI: The<br>same ones of the Level<br>3 for all departments,<br>Number of treated<br>PDCA for each man-<br>agement level for all<br>departments  | PCI and KPI: The<br>same ones as at Level 4<br>for all departments   |

Table 4: POMF-LM description - parameter description from “Improvement Management” family (1/3)

| Levels               | Level 0: State of awareness   | Level 1: Change of perception  | Level 2: Change the way of thinking  | Level 3: Change of behaviour   | Level 4: New habits  | Level 5: Cultural change   |
|----------------------|---|--|--|--|--|--|
| Change Management    | <p>The company is not clear on its vision. An atmosphere of uncertainty exists related to a lack of communication by management on the future of the company</p> <p><b>No engaged process, no structure</b></p> | <p>The managers are trained in Change Management, and they are involved in the project communication inside their department</p> <p><b>PCI:</b> Number of trained managers</p>   | <p>The company defines its project and proposes and deploys a rhythm of communication with employees</p> <p><b>PCI:</b> A3 of the vision and its path; Definition of number and frequency of information meetings</p>  | <p>The company has clearly defined its project and proposes a clear and appealing imagery of it; it has structured a communication rhythm for employees</p> <p><b>PCI:</b> The same ones as at Level 2; Change management standards are formalised; Number of information meetings</p> <p><b>KPI:</b> KPIs related to main changes proposed in the project</p> | <p>A change management process is structured, under control and applied by all managers, with global and local adaptations. The executive team meets periodically to build change and so organises communication on results obtained by the teams</p> <p><b>PCI and KPI:</b> The same as Level 3 for all departments; Compliance with change management standards for all management levels; Calendar of executive team information meetings</p> | <p>New habits are mastered and repeatable. The culture has evolved in the desired direction, the driving dynamics of change is repeatable. The change is continuous</p> <p><b>PCI and KPI:</b> The same ones as at Level 4; Number of Audits</p>                                 |
| Management Standards | <p>The management has no reference framework to answer uncertainties. Decisions are often inconsistent</p>  | <p>The managers are trained in Management standards. They start procedures to describe operating methods or orientations when problems are too obvious</p> <p><b>PCI:</b> Number of trained managers; Number of created procedures</p> <p><b>KPI:</b> Measure of procedure results</p> | <p>The management standard is applied (limited perimeter). Each action has to be followed by a deployment phase that integrates management standards to ensure stability</p> <p><b>PCI:</b> Number of created procedures</p> <p><b>KPI:</b> Measure of procedure results; Diagnosis of in-work relations</p> | <p>Each question asked at station level gives the opportunity to formalise management standards, so that the answer is unique and shared in the organisation and optimises the system overall</p> <p><b>PCI:</b> Management standards formalised; Number of audits</p> <p><b>KPI:</b> Work stress level for local managers</p>                                 | <p>The management standard is implemented on all production lines. Each question asked at the station and line level gives the opportunity to formalise management standards so that the answer is unique and shared in the organisation and optimises the entire system</p> <p><b>PCI:</b> The same as at Level 3 for all production lines</p> <p><b>KPI:</b> Work stress level for local managers; Autonomy measure for middle managers</p>    | <p>Each management activity at local and middle levels of the organisation is under a standard. Some detailed clarifications are part of permanent improvement</p> <p><b>PCI and KPI:</b> The same ones as at Level 4, Measure of the added value by the resources in action</p> |

Table 5: POMF-LM description - parameter description from “Improvement Management” family (2/3)

| Levels            | Level 0: State of un-awareness<br>No knowledge nor method implemented                              | Level 1: Change of perception<br>Acquisition of knowledge and methods concerning parameters management  | Level 2: Change the way of thinking<br>Acquired knowledge is applied, enabling the development of know-how  | Level 3: Change of behaviour<br>the formalisation of the processes allows the re-production of improvement actions   | Level 4: New habits<br>The processes are totally under control, well documented and improved, to that naturally reproducible and controlled work habits can be established  | Level 5: Cultural change<br>Total and collective appropriation of continuous improvement process                              |
|-------------------|--|---|---|--|---|---|
|                   | No engaged process, no structure   | Process non defined but parameters taken into account   | Process defined but not completely controlled   | Process defined and controlled   | Process is implemented in most company departments  | Perfection is sought  |
| Work Standards    | There is no capitalisation on best practices   | The managers are trained in work standard. Some working operations are capitalised on and formalised in routings  | Work standard is implemented but not completely controlled. Some work rules are formalised with a practical point-of-view for the operator. The operators understand why Muri and Muta are eliminated | The work standards integrate all aspects of the actions that the operators have to perform to ensure quality production at a good pace. The standards integrate an ergonomivity approach and are adhered to by the operators | The work standards are implemented on all production lines. Each operator knows how to apply her/his own standards and those for downstream and upstream related activities. Standards for activity volume inferior to full process load exist. For each standard, the right gesture has been defined | The SDCA cycle is completely managed and controlled by operators and proximity managers                                       |
| Visual Management | There is no particular visual tracking. Visual display is not used to create a motivating dynamics | PCI: Number of trained managers; Number of formalised routings  | PCI: The same as at Level 1; Number of operators trained in standardisation   | PCI: Follow-up of training; Number of created standards and audits<br>KPI: Results of audits   | PCI and KPI: The same as at Level 3 for all production lines; Measure of standard effect on activity variability  | PCI and KPI: The same as at Level 4 for all production lines; Number of standards created                                     |
|                   |  | The managers are trained in Visual Management. Some actions are taken to make explanations visual and understandable. 5S actions exist. The pathways are clean and clear<br>PCI: Number of trained managers; Number of 5S actions | 5S is widely applied. An audit process of 5S actions is implemented   | Visual management is used to galvanise and increase value of works performed, with attractive presentation of indicators. Visual Management standards are formalised   | Work environment, actions, tasks, results are clear and visual in all production lines and departments. No anomaly can be missed by managers nor operators  | No anomaly can be missed by anyone in the company, whether untrained or not, or whether a manager at any level or an operator |
|                   |  | PCI: Number of trained managers; Number of 5S actions   | PCI: Number of trained managers; Number of 5S actions and audits<br>KPI: Results of 5S audits   | PCI and KPI: The same as at Level 2; Number of Audits; Satisfaction rate of information quality, of visual form and of spots   | PCI and KPI: The same as at Level 3 for all company levels  | PCI and KPI: The same as at Level 4 for all company levels; Visual KPIs evolution on problem solving                          |

Table 6: POMF-LM description - parameter description from “Improvement Management” family (3/3)

| Levels        | Level 0: State of un-awareness<br>No knowledge nor method implemented     | Level 1: Change of perception<br>Acquisition of knowledge and methods concerning parameters management  | Level 2: Change the way of thinking<br>Acquired knowledge is applied, enabling the development of know-how   | Level 3: Change of behaviour<br>the formalisation of the processes allows the re-production of improvement actions   | Level 4: New habits<br>The processes are totally under control, well documented and improved, to that naturally reproducible and controlled work habits can be established  | Level 5: Cultural change<br>Total and collective appropriation of continuous improvement process |
|---------------|---|---|--|--|---|--|
|               | No engaged process, no structure  | Process non defined but parameters taken into account   | Process defined but not completely controlled  | Process defined and controlled   | Process is implemented in most company departments  | Perfection is sought   |
| Physical Flow | Physical flows are pushed and organised in different sectors              | Managers are trained in production flow and Lean approach and "tools". Some product flows are synchronised but pushed<br>PCI: Number of trained managers  | A comprehensive view of flows is defined. A product-process matrix is defined. Operators are trained in the Lean approach<br>PCI: Visual product-process matrix; Visual flow mapping and associated indicators (lead time, stock level, surface, distance, takt time, etc.)<br>KPI: The same as at Level 1 | The flow organisation becomes value flows. Flows are synchronized and controlled<br>PCI: The value stream mapping is defined (VSM) with a target vision<br>KPI: The same as at level 2; Line balancing schemas | All production lines become value flows, with synchronized and controlled flows. A first pull flow is implemented in a value line<br>PCI and KPI: The same as at Level 3; Variability control of product quality; OEE | All value flows are synchronised and pulled<br>PCI and KPI: The same as at Level 4               |
| Plant Layout  | Workstations are organised by operation type and operators can work alone | Managers are trained in plant configuration and production flow. Some workstations integrate a production line<br>PCI: Number of trained managers<br>KPI: Lead Time; Product quality; Productivity; Customer satisfaction | Some facilities' layout is defined in relation to production process stages<br>PCI and KPI: The same as at Level 1; Number of facilities layout in relation to production process; Number of isolated operators; Versatility level   | In the areas where the facilities are arranged in function of the production process stages, operators are not alone<br>PCI and KPI: The same as at Level 2  | No operator works alone and all workstations integrate a production line<br>PCI and KPI: The same as at Level 3   | Synchronized production in piece-to-piece flow<br>PCI and KPI: The same as at Level 4            |

Table 7: POMF-LM description - parameter description from "Flow Management" family (1/2)

| Levels            | Level 0: State of un-<br>awareness   | Level 1: Change of<br>perception  | Level 2: Change the<br>way of thinking  | Level 3: Change of<br>behaviour   | Level 4: New habits   | Level 5: Cultural<br>change  |
|-------------------|--|---|---|---|---|--|
| Supply Chain Flow | No knowledge nor<br>method implemented   | Acquisition of knowledge<br>and methods concerning<br>parameters management   | Physical flows are pulled<br>by the customers   | Acquired knowledge is<br>applied, enabling the de-<br>velopment of know-how   | The processes are totally<br>under control, well docu-<br>mented and improved,<br>to that naturally repro-<br>ducible and controlled<br>work habits can be es-<br>tablished | Total and collective ap-<br>propriation of contin-<br>uous improvement pro-<br>cess  |
|                   | No engaged process, no<br>structure  | Process non defined but<br>parameters taken into<br>account   | Process defined but not<br>completely controlled  | Process defined and con-<br>trolled   | Process is implemented<br>in most company depart-<br>ments  | Perfection is sought   |
| Information Flow  | The production and sup-<br>ply plan is based on a<br>pushed flow logic, apply-<br>ing the MRP method | Managers are trained<br>in production flow con-<br>sidering the company<br>ecosystem (downstream<br>and upstream flows).<br>Some sub-assembly<br>parts are pulled by the<br>downstream flow | Information flow is con-<br>trolled. The production<br>is pulled by the customer<br>demand. The end prod-<br>ucts are produced every<br>day   | The pull flow is con-<br>trolled. The production<br>is pulled by the customer<br>demand. The end prod-<br>ucts are produced every<br>day  | The production is<br>smoothed over the<br>whole process (from<br>the customer till the<br>supplier) in all com-<br>pany. The value flow is<br>controlled                    | Production is synchro-<br>nised and well adapted<br>to the customers' need.<br>The improvement pro-<br>cess is well implemented<br>inside the company,<br>but it also integrates<br>the relationship with<br>suppliers and customers.<br>Medium- to long-term<br>problems are anticipated<br>by MRP planning |
|                   | Information flows are<br>complex, sector-specific<br>and not clearly defined                         | Managers are trained in<br>information flow tools<br>and reliability of in-<br>formation. The com-<br>plex information flows<br>are mapped  | Information flow is con-<br>trolled, laminar and or-<br>ganised considering the<br>value flows. Information<br>flow standards are for-<br>malised                                       | Information flow is con-<br>trolled, laminar and or-<br>ganised considering the<br>value flows. Information<br>flow standards are for-<br>malised                                 | All the stakeholders con-<br>cerned by the informa-<br>tion value flows have ac-<br>cess only to the informa-<br>tion needed to guarantee<br>their performance              | The process associated<br>with the information<br>flow is well implemented<br>and respected. It is in-<br>tegrated into the design<br>phase  |
|                   |  | PCI: Number of trained<br>managers<br>KPI: End product back<br>orders; component parts<br>back orders   | PCI: The same as at<br>Level 2<br>KPI: End product back<br>orders, component parts<br>back orders, Respect of<br>the upstream planning<br>considering the down-<br>stream requirements  | PCI: Respect of logis-<br>tics contract<br>KPI: Respect of the<br>Logistic planning (pro-<br>duction and supply);<br>End product back or-<br>ders; component parts<br>back orders | PCI and KPI: The<br>same as at Level 4; Re-<br>spect of planning<br>KPI: The same as at<br>Level 3; Customer and<br>Supplier satisfaction                                   | PCI and KPI: The<br>same as at Level 4   |
|                   |  | PCI: Visual information<br>flow mapping and asso-<br>ciated indicators<br>KPI: Lead time  | A comprehensive and<br>clear vision of informa-<br>tion flows is defined<br>PCI: Visual information<br>flow mapping and asso-<br>ciated indicators<br>KPI: Lead time, Wait-<br>ing time | PCI and KPI: The<br>same as at Level 2; Lead<br>time evolution; Informa-<br>tion flow standards for-<br>malised   | PCI and KPI: The<br>same as at Level 3; Ad-<br>herence to process stan-<br>dards for each flow  | PCI and KPI: The<br>same as at Level 4   |

Table 8: POMF-LM description - parameter description from “Flow Management” family (2/2)

| Levels                    | Level 0: State of un-awareness<br>No knowledge nor method implemented  | Level 1: Change of perception<br>Acquisition of knowledge and methods concerning parameters management   | Level 2: Change the way of thinking<br>Acquired knowledge is applied, enabling the development of know-how  | Level 3: Change of behaviour<br>the formalisation of the processes allows the reproduction of improvement actions  | Level 4: New habits<br>The processes are totally under control, well documented and improved, to that naturally reproducible and controlled work habits can be established   | Level 5: Cultural change<br>Total and collective appropriation of continuous improvement process   |
|---------------------------|--|--|---|--|--|--|
| Employee Training         | No engaged process, no structure                                       | Process non defined but parameters taken into account  | Process defined but not completely controlled   | Process defined and controlled   | Process is implemented in most company departments   | Perfection is sought   |
| Employee Training         | The training budget is managed annually on the basis of needs feedback | Company starts to take into account the qualification needs related to development objectives<br><br><b>PCI:</b> Number of real identified needs; Qualification needs related to development expectations<br><b>KPI:</b> Number of trainings | A training process is started. The company take into account qualification needs in a way that is consistent with its development strategy<br><br><b>PCI:</b> The same as at Level 1<br><b>KPI:</b> Rate of trained employees; Expected results for each training | Manager(s) applies the training process and measures the results. The training process is controlled and standardised, with a measure of the results<br><b>PCI:</b> The same as at Level 2; Training process standard visible; Availability of training indicators<br><b>KPI:</b> The same as at Level 1; Number of process audits and results   | The training process is controlled by all managers and standardised with indicators on process and results<br><br><b>PCI:</b> Availability of training indicators in all sectors; Training plan monitoring<br><b>KPI:</b> Rate of people trained according to the training plan; Satisfaction rate of trainings followed; Results obtained after trainings; Gap measures with objectives | Each colleague can follow-up his/her progression and can propose to his/her manager a training process according to the targeted improvements<br><b>PCI and KPI:</b> The same as at Level 4; Individual maturity level; Individual level of skills |
| Temporary Work Management | No monitoring of temporary workers; no implemented integration process | A welcome is established and an integration unit exists<br><br><b>PCI:</b> Number of welcomes / new temporary workers; Number of integration courses followed / registered temporary workers   | An integration process is implemented<br><br><b>PCI:</b> The same as at Level 1   | A qualification and integration process is implemented with temporary employment agencies. It is standardised. There is a traceability of temporary worker qualification. The process is standardised<br><b>PCI:</b> Number of processes formalised / number of temporary employment agencies; Adherence to standards on temporary worker monitoring<br><b>KPI:</b> Number of process audits and results | The qualification level of temporary workers is consistent with the expectations. The work standards are known and controlled by all managers<br><br><b>PCI and KPI:</b> The same as at Level 3; Skills indicators defined by a matrix of skills   | The temporary workers appropriate the company culture, they fully participate in the improvement process<br><br><b>PCI and KPI:</b> The same as at Level 4   |

Table 9: POMF-LM description - parameter description from “Human Resources Management” family (1/2)

| Levels            | Level 0: State of un-awareness<br>No knowledge nor method implemented         | Level 1: Change of perception<br>Acquisition of knowledge and methods concerning parameters management | Level 2: Change the way of thinking<br>Acquired knowledge is applied, enabling the development of know-how | Level 3: Change of behaviour<br>the formalisation of the processes allows the re-production of improvement actions   | Level 4: New habits<br>The processes are totally under control, well documented and improved, to that naturally reproducible and controlled work habits can be established          | Level 5: Cultural change<br>Total and collective appropriation of continuous improvement process   |
|-------------------|---|--|--|--|---|--|
| Skills Management | No engaged process, no structure  | Process non defined but parameters taken into account  | Process defined but not completely controlled  | Process defined and controlled   | Process is implemented in most company departments  | Perfection is sought   |
| Skills Management | The operating skills are not clearly identified                               | Skills are identified  | Skills are identified and evaluated. The evaluation process is implemented but not controlled              | The skills evaluation process is controlled and standardised   | The matrix of skills and skills evaluation process are controlled for all management levels and departments. The matrix of skills is visible and accessible to each concerned actor | The levels of multi-competencies and flexibility are managed, as is the evolution of knowledge on professions. Skills standards are updated when necessary |
| Health Management | No health indicator is implemented and followed up                            | Managers trained in skills management  | PCI: The visible matrix of skills  | PCI: Skills parameters are described; Number of processes standardised; Number of audits of skills evaluation standards; Results of audits carried out by HR                         | PCI: The same as at Level 3 for all management levels and departments   | PCI and KPI: The same as at Level 4 for all employees  |
| Health Management | Social partners disagree with the company project. Negotiations are difficult | The change management process integrates social partners   | A communication process about change management is implemented integrating social partners                 | The health management process is controlled. Experts are defined as are their role and objectives. The process standards are formalised  | A health management process is implemented throughout the company   | Each management level integrates into its health control the employees' well-being at work   |
| Social Relations  | Social partners disagree with the company project. Negotiations are difficult | The change management process integrates social partners   | A communication process about change management is implemented integrating social partners                 | The communication process integrating social partners is controlled. Members of social partners participate to problem-solving actions   | The social and performance issues of the company are addressed in a constructive way  | Employees have the opportunity to become company shareholder, and can receive dividends  |
| Social Relations  | No health indicator is implemented and followed up                            | Managers trained in skills management  | PCI: Percentage of employees trained by theme; Number and qualification of indicators                      | PCI: The same as at Level 2; Number of work standards defined; Follow-up of audits concerning the work standard application; Follow-up of PDCA projects related to health indicators | PCI and KPI: The same as at Level 3 for the entire company  | PCI and KPI: The same as at Level 4 for all management levels  |
| Social Relations  | Social partners disagree with the company project. Negotiations are difficult | The change management process integrates social partners   | KPI: Evaluation of the follow-up of the health indicators control  | KPI: Evolution of health indicators; Availability rate of health indicators; Audits results  | The communication process integrating social partners is controlled. Members of social partners participate to problem-solving actions  | PCI and KPI: The same as at Level 4; Profit sharing level; Employee capital participation rate; Payment of dividends                                       |

Table 10: POMF-LM description - parameter description from “Human Resources Management” family (2/2)

| Levels           | Level 0: State of un-<br>awareness<br>No knowledge nor<br>method implemented   | Level 1: Change of<br>perception<br>Acquisition of knowledge<br>and methods concerning<br>parameters management   | Level 2: Change the<br>way of thinking<br>Acquired knowledge is<br>applied, enabling the de-<br>velopment of know-how  | Level 3: Change of<br>behaviour<br>the formalisation of the<br>process allows the re-<br>production of improve-<br>ment actions   | Level 4: New habits<br>The processes are totally<br>under control, well doc-<br>umented and improved,<br>to that naturally repro-<br>ducible and controlled<br>work habits can be es-<br>tablished  | Level 5: Cultural<br>change<br>Total and collective ap-<br>propriation of contin-<br>uous improvement pro-<br>cess   |
|------------------|--|---|--|---|---|--|
| Work environment | No ergonomics-related<br>actions are implemented<br>in the company. There<br>are no indicators of<br>arduousness and work-<br>station ergonomics | Managers are trained in<br>the ergonomic approach<br>and methods. The first<br>actions are carried out<br>and the first indicators<br>set up<br><br><b>PCI:</b> Number of man-<br>agers trained; Number of<br>actions carried out<br><br><b>KPI:</b> Arduousness indi-<br>cators, Absenteeism rate                            | A process of worksta-<br>tion arduousness scaling<br>is initiated (within a lim-<br>ited perimeter)<br><br><b>PCI:</b> map of worksta-<br>tion ergonomics level<br><br><b>KPI:</b> The same ones as<br>Level 1, Infirmary visits,<br>Occupational diseases | The process of worksta-<br>tion arduousness scaling<br>is controlled by an ex-<br>pert manager (defined)<br>and she/he participates<br>in the ergonomics evalu-<br>ation. The process stan-<br>dards are formalised<br><br><b>PCI:</b> The same as at<br>Level 2; Follow-up of im-<br>provements; Number of<br>work standards defined;<br>Follow-up of audits con-<br>cerning the work stan-<br>dard application<br><br><b>KPI:</b> The same ones<br>as Level 2, Evolution<br>for all workstations pre-<br>sented in the ergonomic<br>level map | The process of worksta-<br>tion arduousness scaling<br>is implemented in all<br>(or almost) production<br>lines. A manager is re-<br>sponsible for this pro-<br>cess, and ensures its per-<br>formance and its effi-<br>cient deployment<br><b>PCI and KPI:</b> The<br>same as at Level 3 for all<br>production lines; Eval-<br>uation and evolution of<br>ergonomics benefits ob-<br>tained; Medical restric-<br>tions of aptitudes                        | Implementation of peri-<br>odic audits to guarantee<br>the level of maturity and<br>the integration of the<br>ergonomics approach in<br>the product and equip-<br>ment design processes<br><br><b>PCI and KPI:</b> The<br>same as at Level 4; Gap<br>between the prescribed<br>and the real; Managers<br>responsible for the in-<br>dustrialisation phase of<br>new product projects are<br>trained in ergonomic ap-<br>proaches and methods |
| Equipment Health | Equipment repairs are<br>performed when hazards<br>occur   | Equipments is re-started<br>by production operators<br>when hazards occur<br><br><b>PCI:</b> Number of haz-<br>ards and accidents for<br>each piece of equipment;<br>Breakdown rate with ty-<br>pology; Hazard cause<br><br><b>KPI:</b> Overall Equip-<br>ment Effectiveness<br>(OEE) of an equipment<br>or a production line | Equipment management<br>process is implemented.<br>Equipment down-times<br>are triggered for im-<br>provements<br><br><b>PCI and KPI:</b> The<br>same as at Level 1; Re-<br>sponse time  | Equipment manage-<br>ment process is con-<br>trolled. Equipment<br>down-time generates<br>problem-solving actions.<br>Equipment management<br>process is standardised<br><b>PCI and KPI:</b> The<br>same as at Level 2;<br>Response time; Indica-<br>tors of the maintenance<br>PDCA approach; Num-<br>ber of created mainte-<br>nance standards; Audits<br>follow-ups concerning<br>compliance with stan-<br>dards; Results of these<br>audits   | Equipment management<br>process is controlled for<br>all production lines. The<br>first level maintenance is<br>done by operators and<br>the breakdown rate is<br>less than 1%<br><b>PCI and KPI:</b> The<br>same as at Level 3;<br>Number of created<br>self-maintenance stan-<br>dards; Percentage of<br>employees trained to<br>self-maintenance stan-<br>dards; Audits follow-up<br>concerning compliance<br>with standards; Results<br>of these audits | Equipment run with no<br>hazard irrespective of<br>the production volume<br>required<br><br><b>PCI and KPI:</b> The<br>same as at Level 4;<br>Number of preventive<br>maintenance standards<br>created.; Respect of<br>preventive maintenance<br>schedule; Percentage of<br>employees trained in<br>preventive maintenance<br>standards  |

Table 11: POMF-LM description - parameter description from “Asset Management” family (1/2)

| Levels           | Level 0: State of un-awareness<br>No knowledge nor method implemented  | Level 1: Change of perception<br>Acquisition of knowledge and methods concerning parameters management  | Level 2: Change the way of thinking<br>Acquired knowledge is applied, enabling the development of know-how  | Level 3: Change of behaviour<br>the formalisation of the processes allows the reproduction of improvement actions  | Level 4: New habits<br>The processes are totally under control, well documented and improved, to that naturally reproducible and controlled work habits can be established | Level 5: Cultural change<br>Total and collective appropriation of continuous improvement process                                 |
|------------------|--|---|---|--|--|--|
|                  | No engaged process, no structure   | Process non defined but parameters taken into account   | Process defined but not completely controlled   | Process defined and controlled   | Process is implemented in most company departments   | Perfection is sought   |
| Financial Health | The company has a deficit<br><br><b>KPI:</b> Profit released; Investment Rate; Percentage of total sales invested in research, innovation and development; Rate of wage bill / turnover compared to those of the industrial sector | The organisation presents a balanced financial situation and produces results corresponding the industrial sector average results<br><b>KPI:</b> The same as at Level 0 | The organisation financial situation is positive and its results exceed the industrial sector average results<br><b>KPI:</b> The same as at Level 1; Costs of occupational diseases and sick leaves | The company invests in its production facilities to ensure the performance level<br><b>KPI:</b> The same as at Level 2; Investment rate in production facilities | The organisation is able to self-finance its activities to ensure its economic growth<br><b>KPI:</b> The same as at Level 3; Cash flow rate                                | The company invests more than 5% of its total sales revenue in R&D<br><b>KPI:</b> The same as at Level 4; Investment rate in R&D |

Table 12: POMF-LM description - parameter description from “Asset Management” family (2/2)