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## **LEAN MANUFACTURING, HUMAN RESOURCE MANAGEMENT AND WORKER HEALTH: ARE THERE SMART BUNDLES OF PRACTICES ALONG THE ADOPTION PROCESS?**

### **LEAN MANUFACTURING, MANAGEMENT DES RESSOURCES HUMAINES ET SANTE AU TRAVAIL : QUELLES COMBINAISONS DE PRATIQUES AU COURS DU PROCESSUS D'ADOPTION?**

#### **Résumé**

Les effets du lean manufacturing sur la santé au travail restent peu étudiés. Si des travaux récents montrent le rôle modérateur des pratiques de management des ressources humaines (MRH) sur cette relation, ils se focalisent le plus souvent sur quelques pratiques spécifiques et n'appréhendent pas leurs effets aux différentes étapes du processus d'adoption. En considérant le lean comme une innovation managériale, l'objectif de cet article est d'explorer la relation entre les pratiques lean, MRH et la santé au travail en prenant en compte explicitement la maturité lean de l'entreprise (i.e. intensité d'usage des pratiques et stade d'adoption). Les résultats, basés sur trois études de cas d'entreprises industrielles françaises, montrent que les effets du lean sur la santé au travail sont à évaluer à la lumière de combinaisons de pratiques lean et MRH qui diffèrent selon la phase du processus d'adoption.

**Mots-clés:** Pratiques lean, santé au travail, pratiques de management des ressources humaines, combinaisons de pratiques, processus d'adoption.

#### **Abstract**

The effects of lean manufacturing on worker health remain poorly understood. Although recent studies show a moderating role of human resource management (HRM) practices on this relationship, they focus only on some specific HRM practices and do not grasp their effects on the different phases of the lean adoption process. By considering lean manufacturing as a managerial innovation, the objective of this paper is to explore the relationship between, lean, MRH practices and worker health according to the firm's lean maturity (i.e. intensity of usage and stage of adoption). The results, based on three case studies of French industrial firms, show that the effects of lean practices on worker health should be assessed in light of the combination of lean and HRM practices that differ along the lean process.

**Keywords:** Lean practices, Worker health, Human resource management practices, Bundles of practices, Adoption process.

## INTRODUCTION

Lean management, whose foundation is the Toyota Production System is one of the most important management innovation (MI) of the twentieth century (Birkinshaw, Hamel, & Mol, 2008). It has been positively linked to multiple dimensions of economic and operational performance (e.g. productivity, cost, quality and time) in the operations and supply chain management literature (Jasti & Kodali, 2015, Shah & Ward, 2003, Souza & Alves, 2018). However, its effects on employee health at work<sup>1</sup> (or similarly worker health) are less explored and remain contradictory (Bouville & Alis, 2014, Erdil, Aktas, & Arani, 2018). These contradictory results may be due to the conception of lean adoption which is too often restricted to a static perspective, that does not take into account the different phases of the lean adoption and tends to exclude human resources management (HRM) practices from investigation (Bouville & Alis, 2014, Chanegrih & Creusier, 2016, Cua, McKone, & Schroeder, 2001, Longoni, Pagell, Johnston, & Veltri, 2013). Indeed, recent works in innovation management and human resource management highlight that the integration of specific HRM practices can significantly moderate the effects of lean on health at work (Bertrand & Stimec, 2011, Longoni, *et al.*, 2013, Stimec, Bertrand, & Michel, 2010). These studies provide some critical insight into the relation between lean and worker outcomes. However, exploring how lean and HRM practices are adopted remains a critical issue (Longoni, *et al.*, 2013) since the combined use of HRM practices might not be always beneficial for employee (Ogbonnaya, Daniels, Connolly, & van Veldhoven, 2017).

The current study addresses these limitations in two ways. First, it examines a full list of lean and HRM practices in line with research that shows that considering bundles of practices can provide a more accurate understanding of lean effects (Bowen & Ostroff, 2004, MacDuffie, 1995, Milgrom & Roberts, 1995, Ogbonnaya, *et al.*, 2017). Second, it proposes a processual approach considering that the different stages of lean adoption can be critical because various factors may differ according to the stage (Damanpour & Schneider, 2006). To the best of our knowledge, no extant research investigates the relationship between lean and health at work integrating a full list of lean and HRM practices in various stages of the adoption process. The current study addresses this research gap pertaining to the complex relationship between lean maturity (in terms of practices and adoption phases), HRM practices and employee health at work.

Empirically, this research is based on a multi-actor qualitative methodology through three case studies of French industrial companies that have adopted lean using the same regional lean program. A stabilized 2-D lean maturity matrix enables precise identification of the lean practices each firm has adopted (Shah & Ward, 2003) as well as their stage of adoption (Damanpour & Schneider, 2006). Moreover, the comparison uses a well-accepted list of HRM practices through high involvement practices (HIPs) (Guerrero & Barraud-Didier, 2004,

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<sup>1</sup> We focus on the concept of employee health at work or worker health (Bäckström & Ingelsson, 2015, 2016; Bäckström, Lagrosen, & Eriksson, 2014; Bouville & Alis, 2014; Longoni, Pagell, Johnston, & Veltri, 2013) that is commonly used in the literature suggesting that the relationship between lean and worker outcomes (job satisfaction, health at work, employees' intention to stay) is related to the manner in which lean is implemented (Bertrand & Stimec, 2011; Bouville & Alis, 2014; Longoni *et al.*, 2013). This conception of employee health at work is in line with the World Health Organization's definition (1946, p100) as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity." This conception has the advantage of addressing health at work in both its positive and negative connotations.

Lawler, 1986). Finally, objective measures of worker health control for potential biases inherent to respondents' subjective scores.(Bäckström & Ingelsson, 2015, Pasmore, 1988) Results confirm the moderating role of HRM practices on the relationship between lean and employee health at work. They also show that the effect of lean practices on health depends not on the intensity of lean and HRM practices firms adopt but rather on the combination thereof. Interestingly, the bundles of practices differ according to the stage of lean adoption. In the early stages of the adoption process, a purely theoretical and technical approach of lean still prevails with negative consequences for worker health. After this theoretical stage, companies are able to make adaptations (Ansari, Reinecke, & Spaan, 2014) using HRM practices in conjunction with lean practices. These adaptations are rather made during the advanced stages of the adoption process (i.e implementation and the routinization phases). They lead to an integrated system, which is more respectful of worker health. Overall, this research advances literature with two points. First, using a processual and multi-dimensional approach of lean, it provides a better understanding of the effects of lean practices on worker health throughout the adoption process. Second, it contributes to the literature on MI by considering the link between this specific type of innovation and an understudied dimension of firm performance, namely, social performance.

## LITERATURE REVIEW

Lean is a noteworthy managerial innovation (MI) (Birkinshaw, *et al.*, 2008, OECD, 2005) whose foundation is the Toyota Production System (Shah & Ward, 2003). Mol and Birkinshaw (2009) define MI as the adoption of management practices, process, structures or techniques new to the firm that are intended to further organisational goals. This innovation is composed of three building blocks, called the 3Ps (Mamman, 2009): philosophy, principles and practices/techniques. It is generally defined from a philosophical perspective, related to guiding principles and overarching goals (Womack & Jones, 1994), or from a practical perspective, describing a set of management practices, tools or techniques that can be observed directly (Shah & Ward, 2007). The philosophy of lean focuses on avoiding cardinal waste, continuous improvement processes and respecting customers, employees and suppliers. Thus, waste elimination, continuous improvement and customer focus constitute its guiding principles (Shah & Ward, 2007).

Although no unified definition of lean is accepted, some authors (Cua, *et al.*, 2001, Jasti & Kodali, 2015, Pettersen, 2009, Shah & Ward, 2003, 2007) have compiled a comprehensive list of lean practices. Cua, *et al.* (2001) identify 29 practices and propose to cluster them in four bundles: total quality management (TQM), just in time (JIT), total productive maintenance (TPM), common practices linked to leadership and strategic management practices. Table 1 summarizes the 3Ps of lean.

*Table 1 – Lean manufacturing: philosophy, principles and practices*

<b>PHILOSOPHY</b>	<b>PRINCIPLES</b>	<b>PRACTICES</b>
To avoid cardinal wastes and respect customers, employees and suppliers	<ul style="list-style-type: none"> <li>• Waste elimination</li> <li>• Continuous improvement</li> <li>• Customer focus</li> </ul>	<ul style="list-style-type: none"> <li>• TQM practices</li> <li>• JIT practices</li> <li>• TPM practices</li> <li>• Leadership and strategic practices</li> </ul>

Identifying lean practices that organisations already use is an effective initial step to assess the level of integration of the lean approach in organisations. Some authors go further by

evaluating the level of maturity regarding actual use of lean practices. For each practice, Lyonnet, Pillet and Pralus (2010) propose evaluating its intensity of use in the organisation using the NEMSE method: the practice is scored as Non-existent or Existent, implemented with a method likely to be generalized (Method), handled methodically, effectively and systematically (Systematic), or its application is efficient and should be communicated (Exemplary).

Beyond the number of practices and their intensity of use, the literature on MI also suggests retaining its adoption phase to evaluate the level of MI maturity. The process of MI adoption has been divided into a variety of phases that can be grouped into three more general phases: (1) *Decision*, which involves becoming aware of a problem, searching for existing innovation, seizing and evaluating opportunities, benefits and suitability, choosing the best ones and allocating the necessary resources; (2) *Implementation*, which consists of activities, events and tactics that pertain to the internal actors' acceptance of MI, being skilful and committed in its use and adapting it; (3) until it becomes an organisational routine (*Routinization*) (Damanpour & Schneider, 2006). The MI adoption is thus conceptualized as a rational and linear process. However, some authors propose to nuance this rational view incorporating the possibility of recursions, intertwined and repeated cycles throughout this process (Zbaracki, 1998). Here, we take this approach and consider that lean maturity can be evaluated along its intensity of use as well as its phases of adoption.

### **Lean and worker health**

Findings are still contradictory regarding the effects of lean on workers (Bruère, 2014, Longoni, *et al.*, 2013). A considerable body of research addresses the *negative effects*. Some studies underscore its impact on work-related musculoskeletal disorders (Brännmark & Håkansson, 2012, Landsbergis, Cahill, & Schnall, 1999, Treville & Antonakis, 2006). Lean is also linked with increased injuries and job depression (Conti, Angelis, Cooper, Faragher, & Gill, 2006), pain, discomfort (Saurin & Ferreira, 2009), high blood pressure, hypertension, cardiovascular disease, psychological strain and distress (Sprigg & Jackson, 2006). Other authors examine the effects of lean on health at work through job satisfaction, showing a significant association with psychosomatic health complaints, stress-related ill-health symptoms and depression. These negative effects result from the continuous need to develop new capabilities and to improve productivity (Askenazy, 2001, Brenner, Fairris, & Ruser, 2004). Reducing time cycles increases work intensity, repetitive movements, worker effort and work-related stress (Kaminski, 2001, Landsbergis, *et al.*, 1999). Furthermore, the combination of increased task variation and lack of competence increases physical stress, risk for disorders and difficulties in filling the production goals (Christmansson, Fridén, & Sollerman, 1999). These ill health complaints also pertain to white-collar work, traditionally considered 'safe' jobs (Carter, *et al.*, 2013).

By contrast, some studies have shown some *positive effects*. Well-being outcomes and beneficial effects of lean include job satisfaction, team working, collaboration and employee involvement, opportunity to develop multiple skills with job rotation, greater autonomy of responsibility, innovation, intrinsic motivation, organisational citizenship, promotion of ergonomic and secure workplace design (Brenner, *et al.*, 2004, Conti, *et al.*, 2006, Hasle, Bojesen, Jensen, & Bramming, 2012, Kaminski, 2001, Perez Toralla, Falzon, & Morais, 2012, Seppälä & Klemola, 2004, Souza & Alves, 2018, Womack, Armstrong, & J.K., 2009). According to (Longoni, *et al.*, 2013), the adoption of lean practices has a positive effect on operational and health performance. Jackson and Mullarkey (2000) and Seppälä and Klemola (2004) show increased breadth of employees' role, cognitive demands, better skill utilization and relations that are more social.

Still other studies show *both negative and positive effects* (Conti, *et al.*, 2006, Jackson & Mullarkey, 2000). Conti, *et al.* (2006) show that lean practices increase work intensity, resulting in a negative effect for employees, but those that increase employees' influence and support have a positive effect. Jackson and Mullarkey (2000) also identify both effects in terms of autonomy, physical demands and social climate. Using a French national database, Bouville and Alis (2014) show that some lean practices (e.g., delegation of responsibilities, problem-solving demand, standardization, job rotation) have negative consequences on job satisfaction, employees' intention to stay and health at work, while others (quality management) are positively linked to these social outcomes.

The literature gives three main explanations for these inconsistent findings. First, lean conceptualizations vary among studies (Hasle, *et al.*, 2012, Parker, 2003). Although consensus on practices associated to lean has emerged, studies rarely take into account a full menu of lean practices or the level of lean maturity (Saurin & Ferreira, 2009). Second, research results are unstable due to methodological inadequacies, which do not control for potential moderators (e.g., organisation's context, culture, management choices, variation in operation of lean systems) (Conti, *et al.*, 2006, Parker, 2003, Saurin & Ferreira, 2009). Third, in some cases, ideological bias has been detected (Schouteten & Benders, 2004).

More recently, to understand the lean effects on worker health, some studies have explored the role of HRM practices as significant moderators (Longoni, *et al.*, 2013). Following this strand of literature, this study embraces the idea that although lean is inherently stressful and worker well-being deterministic; its effects can be balanced with the recognition that HRM practices could play a crucial role.

### **The role of HRM practices on the relationship between lean and worker health**

Conti, *et al.* (2006) show that the relationship between lean and worker job stress is not linear, depending on management decisions in designing and operating lean systems. In this vein, other studies have examined the moderating role of several HRM practices, such as spaces for discussion (Bertrand & Stimec, 2011, Detchessahar, 2003, Stimec, *et al.*, 2010), practices associated with joint regulation between employer and union (Bruère, Bellemare, & Caroly, 2018), employees' involvement (Conti, *et al.*, 2006, Hasle, *et al.*, 2012, Perez Toralla, *et al.*, 2012) or training (Kaminski, 2001). All these HRM practices are positively linked with increased worker health. Despite their advances, these studies have been criticized for considering HRM practices separately. Indeed, recent studies have shown the ineffectiveness of examining only a single type of HRM practice when studying HRM's influence on system or employee outcomes. For example, comparing the integrated and isolated effects of high-performance work practices on employee health and well-being, Ogbonnaya, *et al.* (2017) find evidence that the integrated effects of HRM practices have additional explanatory power on employee outcomes (i.e. employee health and well-being) above their isolated effects. However, their study does not relate specifically to a context of lean adoption.

Other studies on lean support this view by providing a careful examination of the relationship between HRM and lean practices (Cua, *et al.*, 2001, MacDuffie, 1995). MacDuffie (1995) shows that a bundle of 'high-commitment' HRM practices associated with lean practices positively affects plant performance in both productivity and quality. Extending the menu of HRM practices common to TQM, JIT and TPM technically oriented practices, Cua, *et al.* (2001) show that different configurations of practices, both socially and technically oriented, can improve organisational performance. Based on similar practices, Longoni, *et al.* (2013) provide a nuanced perspective of the effects of lean on both operational and worker health and safety performance when a lean adoption model made of bundles of HRM/lean practices is at work. Together, these studies confirm that HRM practices should be implemented as

interrelated elements in a bundle of HRM practices complementary to the lean practice bundle. However, they restrict their investigations to certain high-commitment HRM practices or HRM practices common to lean programs, while a satisfactory study of complementarities between bundles of practices requires a full set of HRM practices (Milgrom & Roberts, 1995). Therefore, the current study adopts a broader definition of HRM practices to ensure that no practice is omitted. In line with Guerrero and Barraud-Didier (2004), the study considers High-Involvement Practices (HIP), which consist in gathering intelligence, ideas and the motivation of all workers. Because HIP are a source of motivation and commitment for employees, they are positively related to performance dimensions (Guest, 2001, Lawler, 1986) such as social performance (Guerrero & Barraud-Didier, 2004). One of Guest (2001) key findings is that the impact of HIP on social performance is stronger when they are combined into a bundle rather than taken in isolation. Recently, Ogbonnaya, *et al.* (2017) obtain a more nuanced result depending on the coverage of practices associated with employees' experience of work intensification. Concerning HIP, Guerrero and Barraud-Didier (2004) identify four categories of core practices widely accepted in the literature: (1) training and skill development practices, (2) motivational incentives and recognition practices, (3) communication and information sharing practices and (4) participation and empowerment practices (see Table 2). We therefore consider this full set of HIP (see Table 2).

Table 2 – A full set of HIP

HIP	DEFINITION
<ul style="list-style-type: none"> <li>• Training and skill development</li> </ul>	Practices aimed at acquiring new skills, developing collective competences and organisational learning
<ul style="list-style-type: none"> <li>• Motivational incentives and recognition</li> </ul>	Practices aimed at rewarding group and employee efforts, including monetary compensation and non-monetary compensation
<ul style="list-style-type: none"> <li>• Communication and information sharing</li> </ul>	Practices aimed at improving communication between groups of employees in terms of content of information or information management, from the top down or from the bottom up
<ul style="list-style-type: none"> <li>• Employee participation and empowerment</li> </ul>	Practices aimed at sharing power and promoting employees' autonomy through task enrichment and work organisation

In sum, there is still neither consensus on the effects of lean on worker health nor on the potential moderating role of HRM practices. Prior studies focus only on some specific HRM practices and consider the transition process to lean as a whole without distinguishing between its different adoption phases (Martínez-Jurado, Moyano-Fuentes, & Gómez, 2013). Therefore, the aim of this study is to take a first step towards a better understanding of the effects of lean on worker health by taking into account a full set of lean and HIP practices and their potential combinations throughout the different phases of the lean adoption process.

## METHODOLOGY

We use a qualitative methodology for several reasons. First, this methodology is well-suited to our exploratory objective (Eisenhardt, 1989, Glaser & Strauss, 1967). Second, lean adoption is treated herein as a complex phenomenon encompassing not only diverse practices but also multiple actors. The richness of the data collected will provide a finer-grained picture of the complexity from different points of view (Miles & Huberman, 1994). Third, because human activity can hardly be studied out of its context, a replication strategy using multiple case studies is optimal (Yin, 2009).

## Case selection

Since our objective is to explore the relationship between lean, HRM practices and worker health by considering lean maturity (in terms of practices and adoption phases), we selected three manufacturing companies, which have all adopted lean but at distinct levels of maturity. All companies adopted Lean with the support of the same regional programme called “industrial excellence”. To provide a robust assessment of each company’s lean maturity, we proceeded in two ways. First, we drew upon the knowledge of consultants who accompanied the studied companies<sup>2</sup>. Second, each managing director completed a self-assessment grid comprising the two dimensions of lean maturity: intensity of lean practices used (number of lean practices adopted among a full menu of 32 practices and their intensity of use, which produces a score) and phases of adoption achieved. We then applied the following criteria to ensure triangulation: cases giving us access to several types of informants (internal and external, from different status) and internal documents. Table 3 gives an overview of the three cases selected, which are presented below.

Table 3 – Sample characteristics

Firms	Industry	Employees	Turnover (K€)	Net profit(k€)	Total equity (k€)	Financial rate of return	Lean Maturity 2014		
							Intensity	Phase <sup>(1)</sup>	
A	Metallurgy	2017	1500	597700	17750	237316	2.87	R	R
		2015	1500	602950	5970	202370			
B	Chemical industry	2017	295	62938	233	18016	3.54	I	I advanced stage
		2015	289	45102	1053	17488			
C	Equipment and machinery manufacturing	2017	30	7936	984	5597	2.45	I	I first stage
		2015	28	5645	413	4060			

Phase <sup>(1)</sup>: Classification from the respondents’ responses in the left column; classification from the consultants’ responses in the right column.

## Brief description of the three cases

**Company A:** Created in 1909, company A is a world leader in stainless steel long products. With its recognized business-specific and technological expertise, it has a strong position in an environment that remains challenging and uncertain. It produces and sells a wide range of products such as bars, wire rods and wires, used in particular in automotive and aerospace industries, medical field, oil and gas production. Company A has always been oriented toward profitability and has a long history with lean: TQM, TPM and World Class Manufacturing, renamed as an internal label in 2006. The majority of lean practices was handled methodically, effectively and systematically. Company A has reached the stage of

<sup>2</sup> The two consultants who were called before the start of the study (in 2015) were also interviewed three years later to obtain additional information on the situation of the companies studied (in 2018), in particular on lean effects, both in terms of economic and social performance.



routinization and a high level of maturity in terms of lean practices from the self-assessment (2.87/5) while this score is clearly under-estimated in the consultant’s view. “*This was the first time I accompanied a company with such a maturity, much better than XX [another emblematic company with regard to lean adoption] that set standards*” (Consultant A). The consultant reinforces this idea explaining: “*in spite of its successive buyouts, the fundamentals are there and the lean adoption has never been called into question* (Consultant A).

**Company B** has been a part of a French pharmaceutical laboratory since 1996. It is organised as an independent profit centre with its own product area. It is a wiper maker in Europe specialized in cosmetics. In a highly competitive environment, company B focuses on cost-reduction and quality improvement. It also seeks to reduce musculoskeletal disorders that are closely related to the activity. Using ISO 9001 quality standard as the starting point in 2008, Company B went further by adopting lean (or ‘continuous improvement’) without any support from its group. Today, Company B is still in the implementation phase with an intermediate degree of use of majority of lean practices. The CEO’s score of lean maturity in terms of practices (3.54) appears to be somewhat overvalued in light of the consultant’s assessment. « *We're talking about a slow process of adoption in this company*” (Consultant B).

**Company C** is an industrial manufacturer specializing in automatic assembly. It was created in 1978, following the acquisition of a French company skilled in wood assembly by a German group specializing in metal assembly. Company C provides a service on joining methods used in mass industrial production for several sectors such as automotive, electrics, electronics and telephony. It benefits from very favourable market conditions, in particular due to the growth in the automotive sector. The firm adopted lean in 2012, based on its ISO 9001 quality standard and is still at the beginning of the implementation phase: about half of the lean practices were implemented, exhibiting a low intensity of use. Compared with respondents’ and the consultant’s statements, the CEO’s lean maturity perception seems overvalued (score = 2.45/5). “*The functional base from which this company started was too low and very little progress has been made*” (Consultant B).

### Data collection and interview protocol

We chose a multi-actor approach and selected respondents who were likely to play a significant role in the lean adoption process, regardless of whether they are operating at a strategic or operational level. For each company, six to nine people were engaged in a rigorous protocol of semi-directed interview (see Table 4).

Table 4 - Interviews conducted

Company	Industry	Number of interviews	Respondents’ positions	Additional data
A	Metallurgy	8	Industrial directors (2); human resource manager (1); middle managers (2); operators (3)	Social Balance Sheet Data Lean Self-assessment Intervention reports
B	Chemical industry	8	General director (1); human resource manager (1); quality manager (1); lean manager (1); middle managers (2); technicians; operators (2)	
C	Equipment and machinery manufacturing	6	CEO (1); administrative and financial director (CFO) (1); quality manager (1); middle manager (1); operators (2)	

REGIONAL PROGRAM	2 at two times	Consultant (2)	Intervention and project reports
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The interview grid consisted of the following themes: (1) characteristics of the respondent, (2) organisational and managerial characteristics, (3) presence or absence of HIPs (in relation to the full set described in Table 2) at the organisational and workplace levels, (4) lean maturity in terms of practices and phases of adoption and (5) lean and worker health (perceived effects). All interviews took place in the workplace to shed light on the respondents' direct environment. The 25 completed interviews lasted one hour on average, resulting in 27 hours of recording and 290 pages of transcripts.

To complement primary data, internal and external secondary data were also collected. First, both internal and external sources have proven essential to complete the lean maturity diagnosis given by consultants and respondents in 2015. Second, worker health indicators within a three-year period (2012–2014) were also collected from each company (see Appendix A). These indicators are in line with the concept of employee health at work or similarly worker health we retain in this research (Bäckström & Ingelsson, 2015, 2016, Bäckström, Lagrosen, & Eriksson, 2014, Bouville & Alis, 2014, Longoni, *et al.*, 2013). All these indicators were valuable to corroborate subjective information gathered during the interviews and to make comparisons (Yin, 2009). Moreover, each participant responded to a series of seven questions (measuring job satisfaction, health at work, intention to stay) at the end of the interview that were formulated using Bouville and Alis (2014)'s constructs (see Table 5). Finally, secondary external sources (websites, newspapers articles, professional magazines as well as reporting of the consultants' interventions, companies' progress and results made available by the pilot of regional program) were helpful to shed light on the economic environment and results of the companies under study.

Table 5 – Constructs operationalization

Construct		Operationalization	Authors
<b>LEAN MATURITY</b>	In terms of practices	32 lean practices auto-assessed by companies through the NEMSE method	Cua, <i>et al.</i> (2001); Lyonnet, <i>et al.</i> (2010); Pettersen (2009); Shah and Ward (2007);
	In terms of adoption phase	Phase indication for each lean practice: DECISION, IMPLEMENTATION, ROUTINIZATION	Damanpour and Schneider, 2006; Damanpour and Wischnevsky, 2006; Klein and Sorra, 1996; Meyer and Goes, 1988;
<b>HIPs</b>		Four bundles: TRAINING AND SKILL DEVELOPMENT, MOTIVATIONAL INCENTIVES AND RECOGNITION, COMMUNICATION AND INFORMATION SHARING, EMPLOYEES' PARTICIPATION	Guerrero and Barraud-Didier, 2004; Guest, 2001; Lawler, 1986;
<b>WORKER HEALTH</b>	Objective measures	HUMAN RESOURCES INDICATORS (all given over 2011–2013): number of departures depending on the status, turnover (in percentage), number of days lost due to workplace accidents, number of days lost due to illness, number of occupational illnesses; expenditures for continuing education (in percentage); Expenditures to improve working conditions, number of hygiene and safety committee' meetings and main issues addressed	Hurrell <i>et al.</i> , 1998 Juglaret <i>et al.</i> , 2011; O'Brien, 2000; Ulrich, 1997
	Subjective measures (perceptions)	Seven questions administrated at the end of each interview to evaluate: JOB SATISFACTION: (1) 'On the whole, I am satisfied with my job'; HEALTH AT WORK: (2)	Bouville and Alis, 2014

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'My work is rather harmful to my health' (3) 'My work is rather detrimental to my health' (4) 'I sometimes cannot sleep because of my job'; (5) 'My work is tiring'; (6) 'My work is stressful'.  
INTENTION TO STAY: (7) Do you intend to change work positions or jobs?'

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## Data analysis

Content analysis was performed. To do so, all data collected were double coded according to the aforementioned themes and related sub-themes. Two researchers were involved at each step of coding and their work was checked by a third one. Coding was not considered complete until all three researchers reached consensus.

## RESULTS

Consistent with our aim, results on the relationship between lean, HIP practices and worker health are presented according to the different phases of lean adoption (decision, implementation and routinization).

### Decision Phase

The three companies justified their decision to adopt lean on the grounds that they expected to achieve better operational results, even if firm B was also preoccupied by its growing problems of musculoskeletal disorders. *"Our objective was to link continuous improvement to versatility because employees' versatility avoids doing things too redundant and is a solution to the growing problems of musculoskeletal disorders" (B - CEO).*

Among the intended operational results, "ongoing improvements of processes and products", "an increase of the overall equipment's effectiveness", "waste reduction" (including the reduction of useless steps in the workshops at company B), "improvements in the quality of service" (service rate) and "customers' satisfaction" were the most cited by the three companies. The financial return objective remained the most frequently cited ground by the three firms. For company B, the firm's profitability was perceived as a necessity for survival in the context of requirements imposed by its group. To deal with these needs, lean appears to be a ready-made solution all the more so because external consultants can help them in their actions. *"Our primary focus was the economic aspect of the company, in particular costs reduction. This is what I call an indisputable truth in such an economic world. A business is legitimate and justified only if it makes profitable. So, at the decision stage, costs were a strong axis. The second strong point, that is partly related to costs, but not only, was the satisfaction of our customers, which is the quality aspect."* (A - Industrial director 1)

*"The fact to be able to do this with external assistance, through training, using lean tools, in a more progressive way was important in our decision."* (C – Quality manager)

At this stage of decision, with the exception of a few internal actors, all companies discover the lean principles and practices through the regional program. The directors and some managers said that they read press articles or media reports on lean manufacturing success stories and best practices. As a result, the decision to adopt lean followed a top-down approach, which remained very theoretical. The lean philosophy was productive, mainly

focused on tools and technical practices without any idea of issues related to managerial aspects.

*“The approach was initially instituted by the steering committee, accompanied by black belts. They give us a list of tools, with things that may have been directive at first; our more general concern was to develop the involvement, to disseminate the tools. So, we pushed people to use the tools: ‘do a SMED, do a Kaizen, do a 5 why’.”* (A- Industrial director 2)

Then, at this stage, lean was perceived as an instrumental system to solve operational difficulties and financial challenges without any managerial foundation. The ignorance of most internal actors led companies to hold simplistic and theoretical expectations about lean.

### **Implementation Phase**

The decision phase had undoubtedly consequences on the implementation one, which could not be considered as a whole process. Our results show different steps of maturity within this phase with specific effects on worker health.

#### ***Step 1: Lean as an instrumental and technical system with negative effects on worker health***

Because of the decision’s turn of events, the first step of the implementation phase was designed on lean theory based on a methodology that adhered to key lean principles, scrupulously modelled on what had been done elsewhere, and involving carefully imitated, ‘formatted’ practices.

**In Company A**, the first step of implementation has been source of tensions among employees as well as managers: *‘At the beginning, we first experienced phases that were somewhat summary, poorly prepared, poorly accompanied, which resulted in semblances of things, failures that ultimately destabilize the employees of the company’* (A - HR manager). The focus was clearly on the technical lean tools, and the human side was overlooked. This focus had a negative effect on employee well-being: stress for the managers who had to follow indicators for which they were not particularly familiar; Unease of the operators and technicians who had to use tools and methods that did not make sense to them; employee difficulties in or even resistance to adopting unilaterally imposed methods; disinclination on the part of the workers and an unrelaxed work atmosphere between the workers who used the lean methods and tools and the ones who were reluctant to use them.

**In company B**, when lean was first put in place, no more than 10 people were involved, mainly employees in charge of production lines, technicians and top managers. All of them attended training sessions led by external consultants. The implementation was difficult given the limited amount of managerial resources allocated. The lean manager, also responsible for purchasing, admits to becoming overwhelmed by the amount of work: *‘Many improvements could be resolved through brainstorming and other lean tools. Unfortunately, I had a little bit of trouble following because of my heavy workload in purchasing tasks’* (B- Lean Manager). This difficulty was reinforced by the structure of the company, which has no middle management, and by values more declared than shared. Shared philosophy and principles of lean were not established within the company in particular because of the top down decision of lean adoption. While some people associated lean with good manufacturing practices oriented towards customer satisfaction, others associated it with principles oriented towards productivity, quality or waste reduction. For some operators, lean represented something external to their workplace: *‘I don’t see lean in my work’* (B - Technician). A respondent noted that practices related to continuous improvement, JIT or quality are not systematic: *‘I do not have the time to do preventive maintenance. It is a black spot’* (B - Technician). Company B also considers lean as a solution to its growing problems of musculoskeletal

disorders but without really thinking about the necessity to include HIP practices. It only places strong emphasis on versatility, job rotation and autonomy to facilitate fast changeover and make jobs less difficult. Lean has no effect on schedules, but changeover times have been greatly optimized as well as working pace. This is one of the lean positive effect on worker health but it was low because company B has not thereby realized the consequences of the just-in-time phenomenon, through ignorance. *"It may be a little more tense. Because in fact, the flow is more tense, so necessarily ..."* (B - HRM).

**In company C**, the first steps of the lean implementation were marked by dissonances and misunderstanding about lean. For the CEO, 'lean' is just a word to name a global process of continuous improvement or *'only a theory'* not achieved in the field. He underscores the disconnection between the quality approach supported by the quality manager, and lean supported by a line manager. Lean philosophy is not shared in Company C. The CEO still considers that experts (here, the quality manager) must think about the work while others execute. This lack of experience about lean has led to oversimplification, reducing it to technical lean practices implemented through instrumental and theoretical approaches. This in turn has led to the production and consumption of lean without an in-depth grasp of its underlying foundation. Few HIP practices are in place and they are not considered as necessary for the lean implementation. Furthermore, the CEO *"had not a delegating style"* (Consultant B) and there were some difficulties within the executive committee. *"To be brief, it was a can of old crabs"* (Consultant B). About HIP practices, training and skill development are limited, disconnected from the lean process: *('Training about lean? There isn't')* (C - Middle manager) The CFO denounced the mismatch between firm needs and training, noting the latter was *'made to please everyone'*. Concerning HIP practices, company C had just begun to set up individual interviews initiated by the CFO: *'We try to ask them questions, to target, with open questions, to make them talk'*. This initiative has surprised some operators, not used to talk about their work. Motivational incentives and recognition practices remain limited and widely non-formal. The line manager tries to increase daily team recognition. *'The recognition? It is made every day by being present and available'* and by promoting some employees *'in relation to what guys have done ... but the board has declined unfortunately all my demands'* (C - Middle Manager). Third, communication and information sharing in Company C are largely informal: billboards near the coffee machine communicate training and *'a mini corporate network on which everyone access and can publish some interesting news'* (CEO). The CFO reported a lack of management and several organisational dysfunctions. He denounced the poor distribution of tasks, useless people and the fact that lean is led by a line manager and not by the quality manager. In addition, the staff manager has tried to offset organisational dysfunctions by staying close to his team: *'I wished my office was in the production workshop, to be always closer to the ground'* to play his role of *'fuse'*, *'buffer'* and *'intermediary'* (C - Middle Manager).

### ***Step 2: First difficulties related to the addition of HIP practices to lean***

As noted above, all three companies reported difficulties and negative effects on employees well-being in the preliminary stages of implementation: stress; unease of the operators and technicians; resistance to adopting unilaterally imposed methods; feeling overwhelmed especially from managers; feeling helpless; work intensification because of the just-in-time production; dissonances and misunderstanding about lean; lack of management support. These first steps led two of the three companies to re-examine the way that they managed its adoption. Therefore, HIP have been integrated step by step to lean practices and methods in a more or less integrated way depending on the companies.

**Company A** has adopted several HIP that have been increasingly incorporated into the lean approach. Amongst these HIP, Company A firstly adopted participative practices such as

workshops to involve all employees in the new work procedures' definition. *'When you are in a working group, you can be consulted. And, lastly, we can influence decision making.'* (A – Operator 1). Second, the firm renamed lean to use an internal label: Atlas. *'I think that the change of name is an element that nevertheless participates in the appropriation of the approach. Lean, doesn't sound French, it was indeed necessary to give a connotation from our universe'* (A – Middle manager 1). Formal communication practices were developed, with meetings at several levels and time scales. The workshops organised around Atlas projects are also opportunities for discussions and for sharing information, achievements, shortfalls and emerging issues. *'The working groups around the Atlas pillars are motivating for them [operators]. They are meeting points, places of exchanges. They are keen on that. And that, I think it is really positive'* ((A – Middle manager 2). The employees value the 'bottom-up' and participatory orientation of these workshops: *'It's basically top down, we're not going to hide it ... except the workshops. That is why they are so important for them [employees]'* (A- Industrial Director). Company A has also developed a dynamic ad hoc training program focused on the Atlas approach. In 2014, 2.9% of the wage bill was devoting to training compared with 2.8% in 2013 and 2% in 2012. Some specific training are also developed for managers to help them to deal with the Atlas practices, methods, indicators and lead working groups. Last, the degree of maturity both in terms of lean and HIP of company A is reflected by a growing awareness of the importance to include a grasp of health and safety issues. A specific pillar of the Atlas approach was developed on this focus, which became a central element of Company A's strategy. Specific indicators of health and safety are communicated and analysed daily. Regular safety audits, effort studies and stress enquiries are performed. *'In the Atlas program there are 12 pillars. The health and safety pillar is now the first one. Therefore, yes, it is totally integrated'* (A – Operator 3).

**Company B** put in use some lean practices, while maintaining a work organization in which the degree of employees' autonomy remains limited, due to the precise standards, highly standardized procedures and strict quality control system. Indeed, Company B can be considered as a hybrid system since it includes lean practices that coexist with a Taylorian philosophy and principles. Employees noted thresholds above which they have no decision-making power: *'When serious problems arise, the decision is no longer in my hands'* (B – Operator 2). The managerial maturity of Company B appears to be weak. The lack of managerial practices is partly offset by a managerial proximity with top managers. First, training and skill development were mainly based on a peer training support system. Trained technicians provided the basic tasks and procedures to operators in charge of production lines, who in turn provided their know-how and interpersonal skills to other operators. If trainers regarded this system as beneficial to their own work, trainees were more critical, considering that *'training could include other aspects than [technical] manufacturing operations; it is something we know how to do very well!'* (B - Operator 1). Social data confirmed that efforts in terms of continuous training did not increase during the 2012–2014 period. Company B has no annual individual interviews, motivational incentives or recognition practices because *'the company's management doesn't want that'* (B - Quality Manager). Employees expressed frustration and demotivation: *'It's really a lack of symbolic gestures. I would say that it can discourage me'* (B – Operator 2). By contrast, other employees see increased responsibility as a benefit despite low wages. Furthermore, apart from billboards in the shop area, communication remains informal. A consequence is the saturation of certain top managers or committees. In the absence of team or workshop managers, the chief human resources officer must deal with all the types of problems on the work floor. Moreover, the lean manager admits that the works council as well as the hygiene, safety and working conditions committee (HSWCC) had become 'catch-all' bodies because employees did not know from whom or where to get information.

Concerning worker health, practices such as versatility, job rotation and teamwork made work less difficult. However, all the issues about health and security have been entirely delegated to the HSWCC. Its annual budget amounts to 250 000€ for 2014 (compared with 150 000€ for 2012). In this context, quarterly meetings with occupational physicians and ergonomists are organised and seem to produce positive effects: *'I would say that about half the requests led to something.'* (B - Lean Manager). Employees are more critical as the focus is rather on safety with the diffusion of information (gestures that should be done), the acquisition of new machinery and equipment that make work less difficult but that are not often used. However, *'what has really changed is the comfort of machinery and the workplace environment as it gets warmer.'* (B - Operator 1). The approach is still reactive and do not allow implementing proactive solutions. *'It must be said there are reactions when the accident occurs. I myself will tell you, there is a lack of prevention'* (B - Operator 2). Social data confirm employees' perceptions, specifying that the cases treated by the HSWCC over the period 2012–2014 focussed exclusively on safety and workstation ergonomics. Health and safety issues delegated to this committee appear to be completely disconnected from the lean approach. Concerning health issues, working in Company B appears to be physically tiresome for operators (5/5) and stressful for managers (3/4). Absenteeism due to accident at work has increased substantially from 65 in 2012 to 197 in 2014, despite the increase in budget allocated to improving working conditions. Employees perceive that efforts have been made about safety to comply with legislation, but little progress has been made on health: *'There is no overall improvement on this issue'* (B - Technician). Moreover, the lack of HIPs has not helped the integration of this issue in the lean context even if *'people [have] become more involved'* (B - Human Resources Manager). The report of the consultant states that they *"failed to anchor the lean and managerial routines"* and that company B tended to *"upgrade the bride when they self-assess their lean maturity level"* (Consultant B).

**Company C** was still at the beginning of the implementation phase five years after the decision to adopt lean. There was no shared representation or philosophy of lean between the CEO, the chief financial officer (CFO), the quality manager, the line manager and operators. For the consultant, who accompanied the company, *"The real job was at the board level. It was necessary to encouraging people to evolve in terms of management."* He called on another consultant in order to bring more cohesion within the board but *"things did not function well."* (Consultant B).

First, training and skill development remain limited, disconnected from the lean process: *'Training about lean? There isn't'* (C - Quality Manager). Second, company C had just begun to set up individual interviews initiated by the CFO: *'We try to ask them questions, to target, with open questions, to make them talk'*. Some operators were very surprised by this initiative because they were not used to talk about their work. Motivational incentives and recognition practices are limited and widely non-formal. Third, communication and information sharing in Company C are largely informal: billboards near the coffee machine communicate training and *'a mini corporate network on which everyone access and can publish some interesting news'* (C- CEO). This network is not limited to corporate discussions but also contains current discussions. A survey on communication modalities indicated *'a poor communication between departments "top-down" and "down-top"'* (C- Quality Manager). A weekly planning meeting was organized but *"sometimes cancelled for three weeks"*, and *'people come without preparation'* (C - Quality Manager), making any progress difficult.

Working in Company C appears tiresome and stressful for top managers (2/3) and stressful for other respondents. Faced with these difficult working conditions, one top manager planned to change his place of work. CEO considers that *'working conditions are awesome in our firm!'*, underscoring that the transition from a historical directive management to a participative one is still in progress. At the same time, the quality manager seems less

convinced: *'I don't know if it is linked with lean... Why not? lean and our own management!'*. This shows that the combination of incompatible, even contradictory, practices destabilize all the company staff except the CEO. Concerning occupational health and safety indicators in the period 2012–2014, Company C reported no accidents at work or occupational diseases. Absenteeism due to illness increased from 18 days in 2013 to 26 in 2014. Expenditures for improving working conditions and preventing risks in terms of health and safety were not disclosed.

### **Routinization Phase**

Only company A really reached the phase of routinization. While the continuous improvement approach has taken years to be implemented and generalized, at the time of the interviews, the lean maturity diagnosis showed that 23 of 32 lean practices had been implemented, and a majority of them (17) were handled methodically, effectively and systematically. *"It took three, four years to initiate an approach that begins to live and to be appropriated by employees."* (A – Industrial Director). Lean practices are integrated into all tasks and missions and are part of the company's everyday language and routines. *'Today, Atlas is in everything in A and used lavishly in our work and in speeches.'* (A – Operator 3). Furthermore, if lean was considered through a theoretical way at the beginning of the process, its philosophy and its system moved forward since then. Its philosophy was based on instrumental and productive foundations and evolves towards managerial foundations including health and safety management. *"At the beginning of the whole process, we had some steps that were a little sketchy, badly prepared, badly accompanied, that led to semblances of things, to failures and that destabilized employees. It was necessary to go through this methodological axis, which was a little painful for people. Today, I think that we have gained in maturity. We pilot a process of continuous improvement, while keeping a methodological base that is part of our know-how and using it more wisely. We have incorporated new pillars centered on well-being through lean practices and health and safety. For us, all this, is Atlas."* (A – Industrial Director). *"Atlas, for me, I would say improving a process, in the sense of quality, safety and productivity."* (A – Operator 2). Unfortunately, the results about health issues, are not so clear, but interviewees provide further evidence of significant improvements in working conditions. The majority of the respondents (5/8) stated that they are more satisfied today with working conditions. However, top managers (2/2) indicated that working in Company A remains physically very tiresome and stressful, and 6 other respondents rated it as stressful as well. The respondents noted that the lean approach increases requirements and challenges, which can be source of stress because many indicators are watched closely. *'What can be scary, this is the number of pillars and the number of indicators you have to manage. [...] it has caused, and I am sure it still causes situations of stress for people who are piloting pillars'* (A – Industrial Director). Regarding worker health indicators along a three-year period, the expenditures for improving working conditions and preventing risks in terms of health and safety have indeed increased by 177% during the between 2012 and 2014. Then, the number of occupational illnesses has decreased by 32 % between 2012 and 2014. However, the number of days lost due to accidents at work and the number of days absent due to illness increased by 49% and 17%, respectively, in the same period.

## **DISCUSSION AND CONCLUSION**



This study extends the conceptualization of lean as a system composed of highly integrated elements (Shah & Ward, 2007). A novel contribution of this study is that HRM practices (from the perspective of HIP), when taken in combination with lean practices, can moderate their damaging effect on worker health and safety along the different phases of the adoption process (i.e. decision, implementation, routinization). The study follows Jasti and Kodali (2015) recommendations that ‘researchers should propose various frameworks along with implementation steps to adapt the particular framework in organisations’ (p.880).

This study reveals several ways in which lean effects on health might be mitigated, depending on how the firm integrates its HIP and lean practices along the adoption process. This link between bundles of lean, HRM practices and worker outcomes has been poorly investigated. Using a full list of HIP and lean practices, consideration of lean philosophy as well as lean maturity (both in terms of practices and adoption phases), the results confirm that the relationship between lean and worker outcomes depends on firms’ ability to combine bundles of technical and managerial practices (Longoni, *et al.*, 2013, Treville & Antonakis, 2006). This study extends Longoni *et al.*’s (2013) statement that ‘*the adoption of lean without the human component is not only mean, it is bad for operational outcomes as well*’ (p. 3314). However, the current study’s findings significantly nuance this. Lean is not a simple, one-way process. Lean is a ‘double-edged sword’ (Adler & Landsbergis, 1988), which depends on how HIP are combined with lean practices, the phase of their adoption and the way of thinking lean. Depending on these elements, lean can degrade or improve health outcomes.

### **Revisiting the relationship between lean, HRM practices and worker health in light of the adoption process: the role of bundles of practices**

In the cases studied, the issue of the effects of lean on employees’ health was deferred until the end of the implementation phase. It was common for the human side to be forgotten during the decision phase and the first steps of the implementation process. Furthermore, the decision to adopt lean was always justified by operational performance without considering the lean philosophy and its compatibility with the Taylorian culture already rooted. Consequently, in the first steps of implementation, lean was put into use by opening a toolbox without giving much thought to its compatibility with company’s culture or technical systems. The adoption process appears to be mainly top-down, driven by a desire to implement lean methodology and tools learned from external consultants, which can be difficult for managers to master due to temporal and material constraints. At this stage, executives did not perceive the difficulties managers and employees faced. Lean without the support of HIP appears to be a difficult process to implement, with a negative effect on employee well-being. This confirms that lean is primarily a management philosophy, which requires the involvement and commitment of everyone (Moyano-Fuentes & Sacristán-Díaz, 2012, Womack & Jones, 1994). Lean adoption entails significant organisational change; therefore, organisations should manage people at the beginning of the process (Treville & Antonakis, 2006).

Realizing the need to connect philosophy, HIP and lean practices often occurs after a long delay.

Mamman (2009) explains that lean philosophy interpretations are diverse: some are poorly developed, oversimplified or inherently contrary to lean principles. The companies that succeed in reaching the routinization phase, have faced difficulties and are often humbler about their lean expertise. They have integrated HIP in the lean system, and specific indicators about worker health complement the previous menu of lean indicators more oriented on wasps, productivity gain, reject rate and so on. At this stage, lean becomes more an integrated system with both technical and HIP, including preventive health practices. In this study, we are sufficiently removed from the beginning of the adoption process (2012) to be able to observe its effects on worker health. In line with de Koeijer, Paauwe and Huijsman

(2014), we consider that changes in work processes resulting from the implementation of lean can lead to improved performance within 6–18 months. In the light of social data collected in 2015, three years later, results look encouraging, but they are not yet entirely satisfactory. The adoption process is not yet complete and continued efforts will be needed to reduce the number of days lost due to work accidents and occupational illnesses.

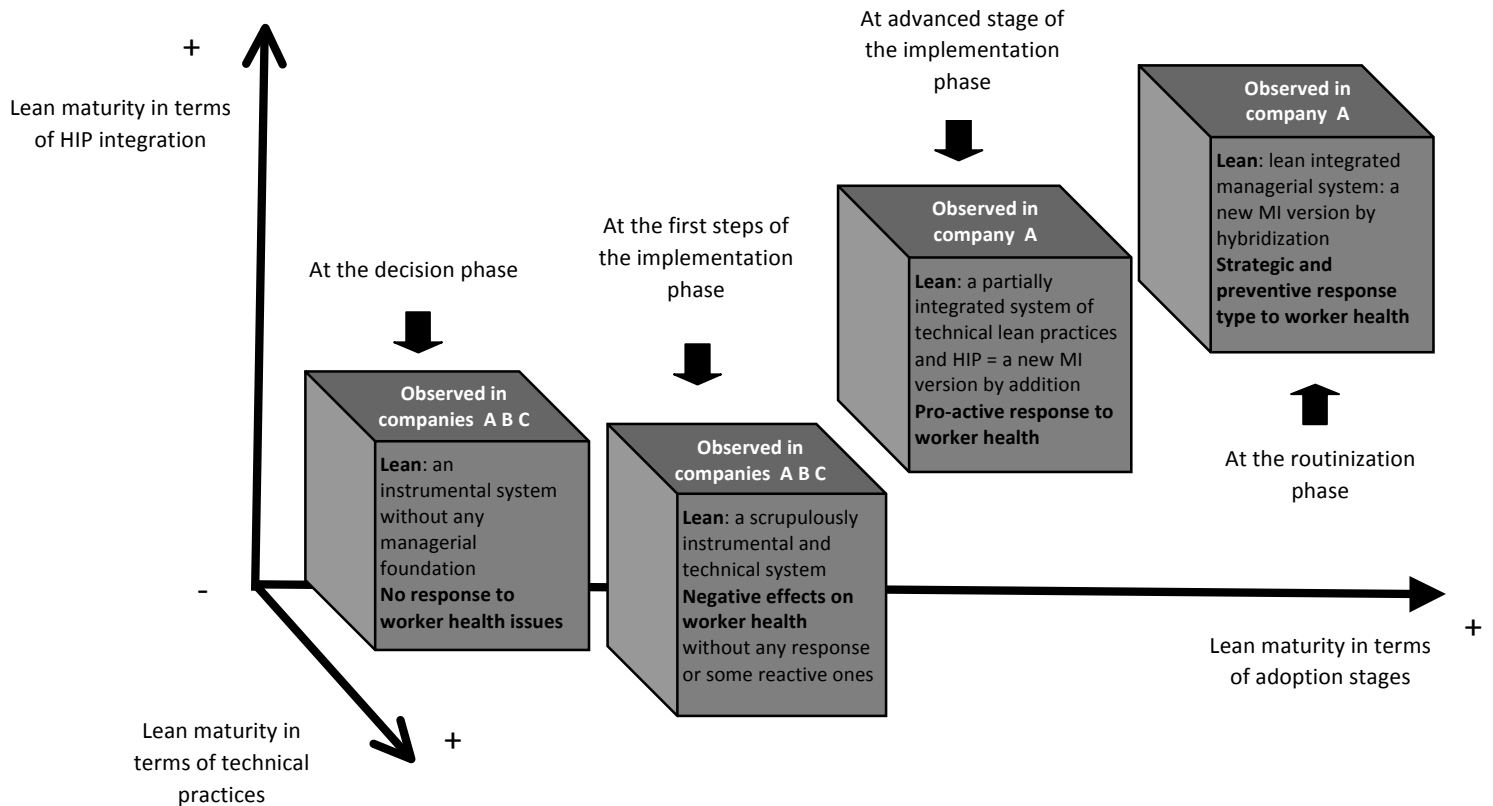
### **Lean as a managerial innovation: a more fine-grained assessment of organization-level practices related to adoption and adaptation**

The findings also nuance the lean adoption framework stemmed from the rational perspective of MI adoption, implying a simple sequence of rational activities that occur relatively automatically. Rather, it involves a complex, systemic, long process, with uncertain phases (Damanpour & Aravind, 2012, Damanpour & Gopalakrishnan, 2001, Gondo & Amis, 2013, Hamel, 2006, Walker, Chen, & Aravind, 2015, Zbaracki, 1998). In line with the cultural perspective of MI adoption (Akrich, Callon, Latour, & Monaghan, 2002, Ansari, *et al.*, 2014, Birkinshaw, *et al.*, 2008, Zbaracki, 1998), our results show that lean as a MI cannot be implemented and routinized without adaptation. We contribute to this perspective showing the crucial role that HIP practices can play for this adaptation at the different stages of the process. We showed contrasting situations in terms of HIP throughout the adoption process. In Company B, they were mainly informal and gave rise to misunderstanding or frustration when some employees were insufficiently recognized and rewarded. This lack of practices oriented toward employees' participation and empowerment hindered the firm from fully appropriating lean practices. Employees' responsibility remained limited when they faced difficulties. Thus, the solution to each problem depends on top managers' reaction, the only ones in a position to answer. This reactive approach is also observed for the health issues delegated to the HSWCC. By contrast, Company A has become so aware of the risks of an instrumental adoption of lean (because it has experienced considerable obstacles in the first and too much theoretical steps of lean implementation), specifically in terms of health, that health issues were used to upgrade existing lean routines with a proactive approach, seeking to transform constraints into opportunities. Participative practices, formal communication and a dynamic training program on the lean approach, and health allow all actors involved to better appropriate lean.

In line with Mamman (2009), our results show the importance to consider MI modification that refers to “changes made to the innovation itself so that it can fit the organizational settings” (p.27). For this author, there does not exist a unique type of MI alteration. Some elements can be omitted (i.e. omission) or added (i.e. addition) from the 3Ps of the MI “to attain make it workable or to meet the organizational or individual goals for adopting the idea in the first place” (Mamman, 2009:41). These two forms of alteration echo what we call a defensive approach, which is observed in the first stages of the lean adoption process. Worker health issues remain largely exogenous and some solutions are proposed in responses to shocks such as injuries, diseases, etc. By contrast, some elements of the 3Ps can be replaced with “new elements” (i.e. substitution) or mixed with elements of 3Ps of another MI (i.e. hybridization) in order to achieve specific objectives. In the light of our results, these types of alteration are a sign of a more proactive and mature approach that allows employees become agents of change. Following Souza and Alves (2018), our result also show that the transition from a technical and instrumental version of lean to a lean integrated socio-technical system requires to pass difficult steps that can have negative effects on worker-health. Organizations face difficulties in operating multiple managerial systems simultaneously to achieve an integrated managerial innovation, which will better respect worker health and render organizations more sustainable.

In summary, such an approach of lean adaptation shows the relationship between lean, HIP and health in a new light that can reconcile previous contradictory results (see Figure 1).

**Figure 1 - The relationship between lean and worker health along the adoption process**



### Contributions, limitations and research avenues

In addition to proposing a method to evaluate firms' lean maturity, this study offers two main new insights for a better understanding of the relationship between lean and worker health. First, previous studies on the effects of lean on health explain the instability of results by the incomplete or inadequate way to operationalize lean (Longoni, *et al.*, 2013, Parker, 2003). In particular, a critical issue emerged concerning the non-inclusion of the multi-dimensional nature of lean (Longoni, *et al.*, 2013). We go beyond this critique by proposing at least a three-dimensional identification of lean maturity: (1) maturity in terms of the technical lean practices adopted by the firm according to its level of expertise; (2) maturity in terms of phases of adoption (decision, first step of implementation, implementation and routinizing); (3) maturity in terms of HIP and the way they are integrated into the lean system. Considering these dimensions, the very nature of lean becomes clear, as well as the differentiated responses to operational health throughout the adoption process (see figure 1).

Up to now, HIP are rarely considered as a valuable dimension of lean. Some previous studies have shown their moderator role in the relationship between lean and occupational health (Bamber *et al.*, 2014; Bruère, 2014; Longoni *et al.*, 2013). Our results indicate something similar with one important difference. It is not sufficient to adopt HIP concomitantly with technical lean practices if they are not fully integrated in the lean system and if they are limited to few disconnected human practices. As observed in company A, continuous improvement practices and health preventive human practices must be combined with

common lean indicators. Following some rare authors (Combs, Liu, Hall, and Ketchen, 2006; Macky and Boxall, 2007; Wood and De Menezes, 2008), this suggests, beyond the traditional HIP identified in the literature, the necessity to consider prevention practices as an important bundle of HIP. In that sense, workers' health does not mean 'more of everything' but depends on their combination in a same 'lean system'. We extend here previous results on the crucial role of configurations (Cua et al., 2001) or bundles of practices (MacDuffie, 1995) by extending the range of both socially and technically oriented practices and by establishing their link with worker health. Furthermore, our results show the crucial explanatory role of the adoption phases on the

Second, this research also contributes to a better understanding of the link between MI adoption and social performance, which is still understudied (Damanpour, 2014). First, results emphasise the complexity and non-linear nature of this link. Workers' health needs the lean process to be adapted, allowing the latitude to employees to make these issues become theirs, but this takes time. We here propose to extend Mamman's typologies of MI modification by considering the different phases of lean adoption. This study has important managerial contributions. First, the research points to the necessity for top managers to make a diagnostic of their lean maturity including their HIP. Except for one firm that reached the most advanced phase, top managers tended to overestimate their degree of maturity in terms of lean practices and adoption phases. Similarly, the managerial practices they declared as effective in their organisation are non-existent in reality. Reducing this discrepancy between discourse and reality is of primary importance.

Too often, firms perceive lean first from a technical point of view while ignoring its potential negative effects on health. Both top managers and consultants should be aware of the crucial role of HIP to adapt lean to organisational culture and anticipate employees and managers' tensions and stress throughout the adoption process. This requires not only the mobilization of new HIP, but their effective integration into the lean system.

Finally, the results provide a recommendation for consultants in charge of accompanying firms in a lean approach: they should rethink their role, which is too often limited to the adoption of technical practices. Important preliminary work must be carried out on the managerial philosophy and "how" lean can be adopted. Similarly, consultants facilitating the adoption of a lean source of operational performance should not overlook social performance. Considering this type of performance should be at the heart of their programme and mission.

This study is not exempt from limitations, which also represent future research opportunities. First, the research is based on three case studies of French industrial companies that have adopted the same regional lean program during their adoption process. A larger sample that includes both companies that used external consultants and those that did not would improve its external validity. Second, this study is based on a cross-sectional design, which does not allow for closely tracking social data throughout the process. Incorporating a longitudinal design could help capture changes in practices and their effects on worker health. Third, the study is focused on internal actors; however, external stakeholders might, for example, favour the diffusion of sustainable practices. Thus, studies could be undertaken to identify the role of the stakeholders in the supply chain. Fourth, a growing body of literature addresses the environmental dimension of lean practices, which results in the new concept of 'green lean'; however, the social aspects of this dimension remain largely unknown. Further work is needed to investigate lean social performance and its antecedents.

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