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The effects of lean organizational practices on employees' attitudes and workers' health: Evidence from France

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Abstract:

Work organization has deeply changed during the last decade, in particular with the introduction of a new type of management production system in the industrial and service sectors – the *lean production system*. Few studies have considered the social outcomes of work organization forms. Using the high-performance work system (HPWS) theoretical framework, we first analyze the influence of these specific lean work organization practices and then study the effect of a lean practices bundle on job satisfaction, employees' intent to stay and health at work. The quantitative analysis that we carried out on a French national database ($n = 24,486$) gives ambiguous results. Our study highlights negative consequences of several lean work organization practices (delegation of responsibilities, problem-solving

demand, standardization, job rotation) on job satisfaction, employees' intention to stay and health at work. However, quality management is positively linked to health at work. Lean work organization practices, as a bundle, have a deleterious effect on attitudes and health at work. To our knowledge, quantitative research has rarely been performed on the effects of a lean practices bundle on attitudes and health at work. Our study shows the contrasting effects and the risks associated with the development of lean production, which leads us to suggest some practical implications.

Keywords: lean management, lean work organization practices, job design, high performance work system, well-being job satisfaction, intent to stay,

1. Introduction

Lean production was popularized during the 1980s and emerged as an important form of production claiming to be beneficial to organizations and their employees (MacDuffie and Krafcik, 1992; Krafcik, 1988; Womack et al., 1990). This form of work organization is widespread in France in comparison with other European countries (Arundel et al., 2007). In recent years, this system has contributed to the introduction of a number of management practices: job rotation, standardization, quality management, broadened responsibilities, and the 'just-in-time' system. Several studies (Coles et al., 2007; Jackson and Mullarkey, 2000; Lewchuk and Robertson, 1996; Parker, 2003; Vidal, 2007a, 2007b) aim at better understanding the effects of lean work organization practices on job satisfaction, intent to stay and health at work. Unfortunately, the results of these studies are contradictory. On one hand, some studies have identified positive effects of lean work organization practices (Mullarkey et al., 1995). On the other hand, other studies have pointed out negative consequences of work organization practices associated with lean (Coles et al., 2007; Jackson et Mullarkey, 2000; Lewchuk and Robertson, 1996; Parker, 2003) or a mixed effect

(Jackson and Mullarkey, 2000). Two explanations can be put forward. One explanation is that most of these studies rest on a sample of employees from two companies at most, which makes the results very dependent on the local conditions. The samples on which these studies are based are too small (e.g. $N = 368$ and $N = 242$ in the studies of Parker, 2003 and Jackson and Mullarkey, 2000, respectively) or too specific to one activity sector (e.g. the automotive components sector in the study of Lewchuk and Robertson, 1996) to enable a generalization of the results. A second explanation lies in the fact that these studies are flawed; as they are based on an imprecise definition of lean production in which different authors imbue the system with different characteristics. Indeed, most of the authors of the previous studies put the label “lean” on the studied companies without precisely explaining what work organization practices or production techniques justify the label “lean”. As pointed out very recently in a review of international peer-reviewed journal articles, “few contributions discuss the basis of lean or provide a clear definition of the meaning of lean. The literature review indicates that there is a low level of operationalization of the concept of lean, making the concept seem unclear and vague” (Arlbjorn and Freytag, 2013: 174). We define lean production as a set of work organization practices pertaining to the way jobs are designed and performed and to the managerial practices that influence job design (Sauter et al., 2002), and of *production management techniques* (e.g. *Total Preventive Maintenance or TPM*, *Single Minute Exchange of Die or SMED*, *Kanban*, *poka yoke*, etc.). In this article, we will exclusively focus on the work organization practices that we consider to be the core characteristics of lean production.

The purpose of this article is to examine whether the claimed benefits of lean production for employees are empirically confirmed. The paper provides a contribution to the lean

production literature in conducting a rigorous empirical analysis through ordinal Logit models of the effects of the specific work organization practices associated with lean production (in isolation and in a bundle) on work-related attitudes and health at work, using a large and representative sample of French employees (n = 24,486). This approach aims at addressing the limitations of previous studies. Indeed, among the few research studies on this subject, most of them separately examine the effects of some lean practices on employees' outcomes. Furthermore, they are based on either automotive case studies or job design models, with a somewhat "rigid" selection of job characteristics (Cullinane et al., 2012: 56).

In the following sections, we will present the hypothesis of our research model. We then discuss these results before proposing a conclusion about the practical implications of our research.

2. Research model and hypotheses

Our research models are presented in figures 1, 2a and 2b. Based on the organizational behavior literature (the employee turnover process model of Mobley et al., 1979) and the HPWS literature (Boxall and Macky, 2009; Kehoe and Wright, 2013; Macky and Boxall, 2007; Vandenberg et al., 2007, Wang et al., 2011), we will analyze the indirect effect of a lean practices bundle on intent to stay via job satisfaction. Finally, we will test the indirect effects of a lean practices bundle on health at work through job satisfaction as this construct has been found to be significantly associated with psychosomatic health complaints, stress-related ill-health symptoms and depression (Faragher et al., 2005).

Figures 1, 2a and 2b about here

2.1. Perceived level of responsibility and its consequences on job satisfaction, intent to stay and employees' health at work

Womack et al. (1990: 14) argues that “a key objective of lean production is to push responsibility far down the organizational ladder. Responsibility means freedom to control one’s work – a big plus – but it also raises anxiety about making costly mistakes”. Workers in lean production are held more accountable due to of the delegation of tasks, such as quality control and maintenance (de Treville and Antonakis, 2006; Jackson and Mullarkey, 1995; Olivella et al., 2008; Womack, 1990). The *andon* system (which implies the right for the worker to stop the line when a defect is detected) has often been held out as a delegation of responsibility to the operators for quality control (Berggren, 1992).

According to the few studies on the subject, perceived level of responsibility is positively correlated with job satisfaction (Bennett et al., 2005). As Edwards and Burnard (2003) and Jackson et al. (1993) have suggested, the higher the perceived level of responsibility, the higher the stress level. Thus, we assume that in lean production systems:

H1a: The perceived level of responsibility is positively related to job satisfaction.

H1b: The perceived level of responsibility is negatively related to health at work.

H1c: The perceived level of responsibility is positively related to intent to stay.

2.2. Standardization and its consequences on job satisfaction, intent to stay and employees' health at work

Standardization is a cornerstone of the lean production system (Liker, 2004; Monden, 1983; Ohno, 1988; Womack et al., 1990; Womack and Jones, 2003). As pointed out by Liker (2004: 38), “standardized tasks and processes are the foundation for continuous improvement and employee empowerment. Use stable, repeatable methods everywhere

to maintain the predictability, regular timing, and regular output of your processes.”

Thus, Vidal (2007a) has found that standardization was implemented in all of the six lean factories that he studied.

This standardization induces a decrease of latitude in scope for determining methods of work (Klein, 1991). Jackson and Mullarkey (2000) found that the implementation of lean production leads to a significant decrease in method control, which “reflects the level of influence individuals have over the methods to use in competing given tasks” (Jackson and Mullarkey, 2000: 233). Individual method control is positively correlated with job satisfaction and negatively with job-related strain (Jackson and Mullarkey, 2000). Since reduced method control is the consequence of an increased standardization (Klein, 1987, 1991; Vidal, 2007b), we formulate the following hypotheses in lean production systems:

H2a: Standardization is negatively related to job satisfaction.

H2b: Standardization is negatively related to health at work.

H2c: Standardization is negatively related to intent to stay.

2.3 Problem-solving demand and its consequences on job satisfaction, intent to stay and employees' health at work

Problem-solving demand reflects the extent of influence individuals have over the resolution of unforeseen problems. The implementation of lean production enhances employee participation in problem solving (Forza, 1990; Fullerton et al., 2003; Kochan and Lansbury, 1997; Liker, 2004; Shah and Ward, 2003; Vidal, 2007a; Womack et al., 1990). As pointed out by Liker (2004: 38), “operators are all involved in continuous problem solving and improvement, which over time trains everyone to become better problem solvers.” Furthermore, in the absence of protection afforded by in-process

inventory, problem-solving activities are likely to increase in the lean production system (Jackson and Mullarkey, 2000). The rise of problem-solving demand caused by implementation of lean increases job-related strain and decreases job satisfaction (Jackson and Mullarkey, 2000). This could be explained by the fact that workers are not ready to assume this role. Indeed, Vidal (2007a: 224), in studying six lean plants, points out that “some workers felt disabled or paralyzed when given the opportunity to engage in decision-making and problem solving (...). Many workers felt unprepared and/or unwilling to take the initiative to engage in problem-solving, independently initiating lateral communication with other workers and engineers, figuring out their own how to ‘see through the end’.” Thus, we assume that in lean production systems:

H3a: Problem-solving demand is negatively related to job satisfaction.

H3b: Problem-solving demand is negatively related to health at work.

H3c: Problem-solving demand is negatively related to intent to stay.

2.4. Job rotation and its consequences on job satisfaction, intent to stay and employees' health at work

Workers in lean production experience a higher level of job rotation (Doolen and Hacker, 2005; Forza, 1996; Fullerton et al., 2003; Karlsson and and Åhlstrom, 1996; Liker, 2004; Panizzolo, 1998; Perez and Sanchez, 2000; Womack et al., 1990).

According to the few studies on this topic, job rotation contributes to an increase in job satisfaction (Mohr and Zoghi, 2008), and to a reduction of both the risk of musculoskeletal disorders (Jorgensen et al., 2005) and the tiredness caused by the over-division of labor (Hsieh et al., 2004). Consequently we propose the following hypotheses in lean production systems:

H4a: Job rotation is positively related to job satisfaction.

H4b: Job rotation is positively related to health at work.

H4c: Job rotation is positively related to intent to stay.

2.5. Quality management and its consequences on job satisfaction, intent to stay and employees' health at work

The implementation of lean production leads to the introduction of quality management (Bayou and de Korvin, 2008; Bunel et al., 2008; Doolen and Hacker, 2005; Forza, 1996; Fullerton et al., 2003; Karlsson and Åhlstrom, 1996; Liker, 2004; Lorenz and Valeyre, 2005; Panizzolo, 1998; Womack et al., 1990). Very few studies have explored the link between quality management and attitudes or health at work. Several studies (Martinez-Costa et al., 2009; Morrow, 1997; Terziovski et al., 1997) have examined the influence of Total Quality Management (TQM) on attitudes in the workplace. However, this research includes highly heterogeneous dimensions to measure the TQM, which makes it difficult to compare their results. Subsequently, in analyzing the findings of the research that studies the effects of ISO 9000 standards on employees' outcomes, we confirmed that ISO 9000 standards is a good indicator of the presence of quality management in an organization (Kojima and Kaplinsky, 2004) since TQM implementation is a precursor to ISO 9000 registration (Whiters et al., 1997). To our knowledge, few studies have examined this relationship. According to Elmuti and Kathawal (1997), there is a negative correlation between ISO 9000 certification and perceptions of quality-of-work life by employees. In contrast to this study, Askenazy and Caroli (2002) have shown that the correlation between ISO certification and the number of work accidents is positive when certain variables related to work organization and to the socio-demographic characteristics of the employees are controlled. The influence of the ISO 9000 standards on health at work is

subject to debate. Rahimi (1995) argues that the ‘philosophy’ of quality management is conducive in improving the work environment and health. This idea converges with the principles of the ISO 9000 certification (and more particularly ISO 9001 certification), which include guidelines on the work environment. Thus, in the requirements of the ISO 9001 standards, a very short paragraph about work environment specifies that “the organization shall determine and manage the work environment needed to achieve conformity to product requirements” (Quality management systems - requirements, ISO/DIS 9001, 1999, p.7). However, Karlton et al. (1998) conducted a longitudinal survey of six firms that obtained the ISO 9001 certification, which led to an increase in the assignment of meaningless tasks, stress levels, and physical strenuousness. Moreover, if we consider this research, we can assume that quality management increases the density of work. Work density corresponds to the fact that performing one given task can lead to the concurrent carrying out of other micro-tasks (Ughetto, 2007); this is the case when an employee must not only perform an action, but must also account for it in the form of a written report (for example, reporting a detected defect). Edwards and Burnard (2003) point out that an increase in the administrative tasks of reporting has been the source of high stress levels among nurses.

In view of these results, we can state the following hypotheses about lean production systems:

H5a: Quality management is negatively related to job satisfaction.

H5b: Quality management is negatively related to health at work.

H5c: Quality management is negatively related to intent to stay.

2.6. *Lean* bundle and its consequences on job satisfaction, intent to stay and employees' health at work

In the literature, there are strong debate on the effects of lean on attitudes and health at work. Some authors (Monden, 1983; Womack et al., 1990) claim that lean production system increases the well-being of workers. Monden (1983) argues that lean represents a respect-for-human-system where employees work smarter and not harder. Womack et al. (1990: 100-102) see lean production system as a “creative tension” that makes work “humanly fulfilling”. Other authors (Babson, 1993; Haynes, 1999; Jackson and Mullarkey, 2000; Landsbergis et al., 1999; Lewchuk and Robertson, 1996; Valeyre et al., 2009) point out the deleterious social and health impact of lean on workers. To our knowledge, few quantitative studies have analyzed the effects of a lean work organization practices bundle on attitudes and health at work. With the notable exception of Valeyre et al. (2009), these aforementioned studies give no insights into the degree of lean implementation or the effect of the implementation of a lean work organization practices bundle. To our knowledge, only two quantitative studies compared the effect of work organization on worker health (Lewchuck and Robertson, 1996; Valeyre et al., 2009). Lewchuck and Robertson (1996) compared four types of Canadian automotive organizations: lean production plants, plants changing to lean, Ford mass production plants and “exploitative” plants. Among the 1,670 workers from 16 plants who answered the questionnaire, lean workers reported higher intensity of work and higher levels of job stress. However, Lewchuck and Robertson give no details about the degree of lean implementation or the effects of specific work organization practices.

Valeyre et al. (2009) compared four forms of work organization in Europe based on those of Arundel et al. (2007): discretionary learning, lean production, Taylorist, Traditional or simple. In comparing the physical working conditions in the two new or

innovative forms of work organization – the discretionary learning and lean production forms – all physical risk exposures were lower in the former than in the latter.

Moreover, whereas physical risk exposures were lower in the discretionary learning forms than in the Taylorist forms, this was not always the case for the lean production forms. In addition, employees believed that their work posed a risk to their health and safety in the two innovative forms of work organization – the discretionary learning (18%) and lean production forms (36%) – in comparison with 37 % for the Taylorist forms (Valeyre et al. 2009). Despite these scarce studies, we still lack empirical evidence of the social and health impact of a lean work organization practices bundle.

The results of this research confirm a deleterious social and health impact of lean production. Thus, based on these studies, the employee turnover process model (Mobley et al., 1979) and the HPWS literature (Boxall and Macky, 2009; Kehoe and Wright, 2013; Macky and Boxall, 2007; Vandenberg et al., 2007, Wang et al., 2011), we can formulate the following hypotheses about lean production systems:

H6a: Lean work organization practices bundle is negatively related to job satisfaction.

H6b: Lean work organization practices bundle is negatively related to health at work.

H6c: Lean work organization practices bundle is negatively related to intent to stay.

H6d: Job satisfaction mediates the negative relationship between lean work organization practices bundle and intent to stay.

H6e: Job satisfaction mediates the negative relationship between lean work organization practices bundle and health at work.

3. Research method

As mentioned above, the weakness of many studies on employees' outcomes of lean production lies in the fact that the samples of surveyed people are small. These small sample sizes do not enable researchers to control the confounding effects of particular factors (age, sex, profession, etc.). For this reason, we have chosen to use the data from the Sumer 2002-2003 survey, which examined 24,486 employees. The 'SUMER 2002-2003' survey was jointly conducted by the DARES (Directorate for Research, Studies and Statistics) and the Directorate of Labor Relations of the Ministry of Employment, Social Cohesion and Housing in France. SUMER 2002-2003 is a cross-sectional survey of 24,486 employees. The SUMER survey consists of an inventory of employees' main organizational constraints and their physical environments.

We have measured the independent and dependent variables using the questions provided by the SUMER survey. In this context, we have tried to build, when possible, synthetic indicators that combine a subjective dimension (corresponding to the survey's questions based on the self-questionnaire) and an objective dimension (corresponding to the survey's questions, based on an assessment of the working conditions by the occupational physician in the presence of the employee) so as to reduce the risk of common method bias. According to the items present in the SUMER 2002-2003 survey, we have defined indicators measuring the independent and dependent variables.

We now present the items used in the analysis to define the indicators measuring the work organization practices that are characteristic of lean production.

- *Perceived level of responsibility*: This is measured by four dichotomous items (see Appendix), which are similar to those in Jackson et al.'s measurement scale (1993). The Kuder- Richardson coefficient is equal to 0.68. This variable was dichotomized at

the median and coded 1 for 'high level of responsibility' and 0 for 'low level of responsibility'.

- *Standardization*: We used three items to measure this variable. The first item 'In your job, have you had the possibility to change the order of the tasks to be performed?' was coded 0 for 'yes' and 1 for 'no'. The second item 'In your job, have you had the possibility to change the deadlines' was coded 0 for 'yes' and 1 for 'no'. The third item 'In my job, I have no scope to choose the way I carry out my work' was coded 1 for 'yes' and 0 for 'no'. These three items were aggregated in a dummy variable that equals one if there is at least one form of standardization among the three forms.

- *Job rotation*: We have selected the following item to measure this variable: 'Do you occupy different work stations?' The answer was coded 1 for 'yes' and 0 for 'no'.

- *Problem-solving demand*: In accordance with Jackson et al. (1993), we assessed problem-solving demand with the following Sumer item 'In your work, have you had the possibility to solve a problem, should one arise?' The answer was coded 1 for 'yes' and 0 for 'no'.

- *Quality management*: In order to take into account the items present in the SUMER survey, we have chosen to measure the implementation of the quality management system with a "quality index" (Kojima and Kaplinsky, 2004: 201) – the ISO 9000 certification – for two reasons. Firstly, it seems difficult to directly measure quality management as it consists of several sub-practices (quality circles, Kaizen, formalization of procedures, zero default). Secondly, the ISO 9000 standards, and more specifically the ISO 9001/2000 standards, include principles of quality management such as continuous improvement (Martinez-Costa et al., 2009). Thus, according to the Réponse 2004 survey, 56% of the French firms have adopted the quality management system in order to comply with the ISO 9000 standards. It is the approach followed by Kojima and Kaplinsky (2004) in the construction of a quality index of lean production measurement. The variable 'ISO standard' is measured by the following dichotomous indicator: 'Your establishment is ISO certified or in the process of getting the certification.' The answer was coded 1 for 'yes' and 0 for 'no'. The SUMER survey does not ask the respondents to specify the type of ISO standards they are certified in, but we can

assume that in most cases they are the ISO 9000 (9001, 9002, 9003), as this type of ISO standard is the most widespread. Indeed, according to the 12th cycle of the ISO Survey of ISO 9000 and ISO 14001 Certifications (2003), France was in the top ten regarding the number of certified ISO 9001 firms in 2003, before Switzerland and United-States.

- *Lean bundle*: We constructed a dummy variable 'lean bundle' and coded 1 with the case of exposition to the combination of all lean work organization practices (standardization, level of responsibility, job rotation, problem-solving demand, quality management), 0 with the case of no exposition to this combination of all lean work organization practices.

On the basis of a selection of items provided by the Sumer survey, we have defined the indicators for measuring job satisfaction, health at work and employees' intent to stay.

- *Job satisfaction*:

The question asked in the SUMER survey is the following: 'On the whole, I am satisfied with my job'. Although the reliability of a one-item scale is lower than that of a multi-item scale (Peterson, 1994), it is still appropriate (Warnous et al., 1997; Kunin, 1955). In the context of our research, overall job satisfaction is measured with a 4-point scale.

- *Health at work*:

In accordance with the World Health Organization (1946: 100), we define health at work 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 in both its positive and negative connotations (Althaus et al., 2013). The first type of variable is related to employees' overall perceptions of what they consider as health problems resulting from work ('my work is rather harmful to my health'). The second category of variables pertains to different types of health problems at work, as perceived by employees. One of the variables characterizes the physical condition of tiredness. Two other variables are related to psychological ailments of stress and insomnia. The four items measuring health at work are therefore the following: 'My work is rather detrimental to my health'; 'I sometimes cannot sleep because of my job'; 'My work is tiring'; 'My work is stressful', Cronbach's Alpha equals 0.62. We have reversed and divided the sum of these four items by quartile. The final scale for health at work has four answer options ranging from 1 (very poor) to 4 (very good).

- *Intention to stay:*

The ‘intention to stay’ was measured, as in many other studies (Martin and Hunt, 1980; Sagie, 1998; Spector and Jex, 1991; Van Yperen et al., 1996), with a 3-point scale: ‘Do you intend to change work positions or jobs?’

- *Confounding variables:*

In order to reinforce internal validity, we have controlled for a number of the determinants of job satisfaction, intent to stay and health at work that are identified in the literature pertaining to the subject (Clark et al., 1996; Houtman et al., 1994; Niedhammer et al., 1998; Griffeth et al., 2000). These variables are potentially confounding; that is to say, they are factors that might conceal the relationship between a dependent variable and its probable cause. Consequently, we control for the effects of socio-demographic characteristics (age, seniority, socio-professional category, and sex of employees), societal characteristics (employment status, type of working hours) and the characteristics of the organization (size of the organization, presence of a Committee for Health and Safety at Work [CHSW], sector of activity) on job satisfaction, intent to stay and health at work.

Tables 1, 2 and 3 about here

With regards to methodology, we have used ordinal Logistic regressions. After checking the endogeneity of our models, we have found that no regressors are correlated with the error terms ε (see Tables 1 and 2). Therefore, the use of instrumental variables is not necessary (Foster, 1997; Greene, 1993). To test the effects of mediators (job satisfaction and health at work), we use the Baron and Kenny (1986) procedure. To test that the independent variable was significantly related to the mediator (which is the second condition to fulfill in order to confirm a mediation effect according to Baron and Kenny, 1986), we use ordinal logistic regression on the two mediators (job satisfaction and health at work). We report Kendall's tau-b correlation coefficients because all the lean work organization practices are dummy variables. These associations are for the most part statistically significant, though small (Table 3). Lean bundle is positively correlated with each work organization lean practices.

4. Results

We shall distinguish the results pertaining to the relations between lean work organization practices and employees' attitudes (job satisfaction and intention to stay) or health at work and those relative to lean bundle.

The first results are described in Table 4. With regards to the influence of the perceived level of responsibility (H1 a,b,c) only hypothesis H1b is confirmed. The perceived level of responsibility is associated with a lower level of health at work (Table 4, $\beta = -.535, p = .000$). H1a,c are not confirmed since perceived level of responsibility is associated with lower levels of job satisfaction and intent to stay (Table 4, $\beta = -.131, p = .000$; $\beta = -.108, p = .000$). Secondly, hypotheses H2a,b,c about the influence of standardization are confirmed: standardization is associated with lower levels of job satisfaction, intent to stay and health at work (Table 4, $\beta = -.321, p = .000$; $\beta = -.245, p$

=.000; $\beta = -.202, p = .000$). Thirdly, problem-solving demand (the ability for an employee to solve unexpected problems) is associated with a worsening of health at work (Table 4, $\beta = -.133, p = .000$). This provides support for hypothesis H3b. No significant associations were found between problem-solving demand and intent to stay or job satisfaction (Table 4, $\beta = -.058, p = .102$; $\beta = .004, p = .909$). H3a,c are not confirmed. Fourth, contrary to the expected results, job rotation is negatively correlated with intent to stay (Table 4, $\beta = -.191, p = .000$) and job satisfaction (Table 4, $\beta = -.119, p = .000$). Also, job rotation is associated with worse health at work (Table 4, $\beta = -.186, p = .000$). Hypotheses H4 a,b,c are therefore not confirmed. Finally, quality management is positively (and not negatively, as had been expected) correlated to health at work (Table 4, $\beta = .065, p = .026$). Quality management is associated with lower levels of job satisfaction (Table 4, $\beta = -.093, p = .004$) and intent to stay (Table 4, $\beta = -.082, p = .014$). Hypothesis H5a,c are therefore validated, but hypotheses H5 b is not confirmed.

Table 4 about here

Tables 5 and 6 about here

Table 5 presents the influence of the lean work organization practices bundle on job satisfaction, health at work and intent to stay (Table 7 in appendix shows the estimated effects including the control variables ones). Lean bundle is negatively associated with job satisfaction, health at work and intent to stay (Table 5, $\beta = -.344, p = .000$; $\beta = -.452, p = .000$; $\beta = -.307, p = .000$). Therefore, a lean work organization practices bundle is associated with a worsening of employees' attitudes and health at work. Hypothesis H6a,b,c are confirmed.

In order to validate hypothesis H6d and H6e, we apply the Baron and Kenny (1986) procedure to test a mediation effect. The first condition is verified when testing hypothesis H6a. The second condition is also met since hypothesis H6b and H6c are supported. The third condition is also confirmed. The effects of lean bundle on intent to stay and health at work is still significant but the coefficients associated to the lean bundle variable decrease when we include job satisfaction in the model (Table 6, $\beta = -.307, p = .000 \rightarrow \beta = -.201, p = .000$ for intent to stay; $\beta = -.452, p = .000 \rightarrow \beta = -.382, p = .000$ for health at work). Overall, these results suggest that job satisfaction partially mediates the relations between lean bundle and intent to stay or health at work, thereby providing support for hypothesis H6d and H6e.

5. Discussion

In general, the results support the models presented in figures 1, 2a and 2b. We will discuss the relationships between the variables responsibility, standardization, problem-solving demand, job rotation, quality management and lean bundle and employees' attitudes or health at work.

Firstly, with regard to perceived level of responsibility, we find that the higher the level of responsibility of an employee, the greater the probability that his/her health

deteriorates – all other things being equal – and in particular, regardless of his/her socio-professional category. An "all other things being equal" analysis was necessary, given how intercorrelated the examined phenomena are, and how the effect on health at work (of the socio-professional category) can be confused with the effect of the perceived level of responsibility. This result is in accordance with the results obtained by Edwards and Burnard (2003) and Vidal (2007b). Vidal shows in a qualitative study with in-depth interviews on workers in nine lean or HPWO factories how "increased involvement and responsibilities can increase frustration and stress" (2007: 266). This is consistent with empowerment strategies (Conger and Kanungo, 1988) that consist of delegating and decentralizing decision-making. Underlying the lean production model is the idea that increased responsibility should enhance workers' motivation (Askenazy and Caroli, 2010). However, these new forms of work organization via empowerment can lead top management officers to 'subcontract' sometimes contradictory obligations – which they are supposed to manage – to lower level employees. The latter are not necessarily adequately prepared to take on such tasks, and thus, this decentralization generates problems of stress and dissatisfaction at work among the concerned employees. As analyzed by Vidal (2007b: 263), "In many cases it does not appear: a desire for broadened work responsibilities and a broader understanding of the overall process". This could explain why the sign of the relationships between perceived level of responsibility (regardless of the socio-professional category) and job satisfaction or intent to stay is negative (Table 4, $\beta = -.131, p = .000$; $\beta = -.108, p = .000$). Sequential sorting of the Sumer survey's sample of employees with a high perceived level of responsibility (coded 1) in comparison with low perceived level of responsibility (coded 0) strengthens this explanation, as it shows that the perceived level of responsibility is not dependent on the socio-professional category. Indeed, among

employees with a high perceived level of responsibility, 38.6% are blue-collar workers, 29.6% are workers with intermediate occupations, 13.8% are white-collar employees and only 18.0% are clerks. This great proportion of blue-collar workers with a high perceived level of responsibility may be explained by the fact that blue-collar workers working in lean companies must fulfill quality norms. Yet, quality norms are strongly correlated with a greater sense of responsibility with respect to the quality of the product and to the financial consequences of errors (Askenazy and Caroli, 2003, 2010). According to Askenazy and Caroli (2010: 549), “workers involved in quality norms have a 10 point higher probability of being aware of the financial consequences of their errors than workers who are not”.

Secondly, our results demonstrate that standardization deteriorates employees’ attitudes and health at work. Indeed, as showed by Klein (1991), standardization means a loss in the scope for determining methods of work for the worker, which induces dissatisfaction and higher job-related strain (Jackson and Mullarkey, 2000).

Thirdly, problem-solving demands have a negative influence on health at work. This may be explained by the lack of significant resources for training, which makes workers feel stressed when given the opportunity to be involved in problem solving (Vidal, 2007a). However, contrary to our hypothesis, problem-solving demands have no significant relationship with job satisfaction or intent to stay. As found by Vidal (2007b), the feelings of lean workers about problem-solving demands are ambiguous and confused. Actually, problem-solving demands could be perceived at the same time by the workers as more ‘challenging’ but also as a source of frustration and stress. This ambiguous effect of problem-solving on job satisfaction could explain our insignificant results about employees’ attitudes.

Fourthly, as far as job rotation is concerned, it is associated with lower levels of job satisfaction and intent to stay. Therefore, job rotation does not have the desired effects on employees' intent to stay and job satisfaction. This result can be explained by the fact that job rotation may no longer be a sufficient condition for an operator to gain access to middle management jobs; acquiring a diploma may also be necessary (Eckert and Monchatre, 2009). Thus, job rotation might now be but a vector of evolution within a segment of employment (Eckert and Monchatre, 2009), which would sharply decrease its positive influence on employees' intention to stay. We can also assume that the employees experience this form of job rotation more as a 'stopgap' than as a source of self-fulfillment. Moreover, contrary to the expected results, job rotation has no significant effect on employees' health at work. This result could be explained by the fact that the development of job rotation is seldom combined with that of 'multi-skilling' (the possibility of performing complex tasks by mobilizing various skills). Thus, while on average 24.1% of the survey population has high monotonous tasks, this percentage goes up to 25.8% for workers exposed to job rotation. In the same manner, while on average 18.3% of the survey population has high skill demanding jobs, this percentage decreases to 17.2% for workers exposed to job rotation. Similarly, we believe that rotating between different jobs, all of which are characterized by repetitive tasks, has neither beneficial effects on attitudes nor health.

Furthermore, we can assume that quality management was associated with lower levels of job satisfaction and health at work due to the increase in work density (e.g. reporting tasks) that it generates. But counter-intuitively, quality management is associated with better health at work. This could be explained by the fact that within organizations, ISO certification (that is our quality management indicator) is often associated with the presence of a Committee for Health and Safety at Work (or CHSW). Quality

management and the presence of a Committee for Health and Safety at Work seem to go hand in hand in ISO certified firms, and indeed, the Chi² test is statistically significant. Thus, while on average 92% of firms with more than 50 employees have a CHSW, this percentage rises to 95.6 % for ISO certified firms with over 50 employees. In the case of firms with fewer than 50 employees, the gap is even wider: 34.4% of ISO certified firms with fewer than 50 employees have a CHSW whereas on the whole, only 15.8% of the organizations with fewer than 50 employees have a CHSW. Furthermore, the presence of a CHSW has a beneficial effect on health at work via the prevention policies implemented by the CHSW (Walters et al., 2005; Popma, 2009). This is in accordance with Rahimi's argument (1995) that the improvement of the quality of products, provided services, health and the work environment are interrelated.

In the discussion of lean production effects on employees' attitudes and health at work, we confirm the claim of some academics (Babson, 1993; Haynes, 1999; Landsbergis et al., 1999; Lewchuk and Robertson, 1996). Lean work organization practices, as a bundle, have a deleterious effect on attitudes and health at work. Our results are convergent with the last literature review of studies on the impact of lean production on worker health (Landsbergis et al., 1999). The automotive industry studies identified by the authors suggest that lean production creates intensified work pace and high job demand with low job control, thus characterizing job strain (Karasek and Theorell, 1990). Such effects are claimed to result from the just-in-time system leading to the intensification of work. Indeed, the just-in-time system leads to the removal of buffer stocks and thus, sharply reduces the length of employees' micro-pauses (Haynes, 1999; Landsbergis et al., 1999). Moreover, with the just-in-time system, workers have to comply with rigid cycle times and are expected to adjust immediately to changes as

demand fluctuates. Thus, the stress levels are higher among line operators under just-in-time systems (Klein, 1989). In the literature, the intensification of work is presented and empirically verified as one of the main consequences of the just-in-time system (Haynes, 1999; Landsbergis et al., 1999; Lewchuk and Robertson, 1996).

6. Conclusion

In the unresolved debate on the lean production practices on employees' outcomes, this study, one of the few evaluations of lean production on a large-scale survey, makes several contributions.

First, to our knowledge, it is the first research of lean production to study the effects of two work organization practices related to lean production: quality management and delegation of responsibilities.

Second, our study highlights that a number of work organization practices associated with the lean production model (delegation of responsibilities, standardization, job rotation, quality management) lead to the worsening of employees' attitudes (job dissatisfaction, desire to leave one's employer) and employees' health at work.

Conversely, other work organization practices associated with lean production (quality management) have a beneficial influence on employees' health at work. Therefore, the effects of work organization lean practices on employees' attitudes and health at work appear to be ambivalent. ISO standards are emblematic of this ambivalence of the lean production system, as they tend to improve health at work while contributing to a decrease of job satisfaction and intent to stay levels. Thus, our study demonstrates that the claims about the benefits of lean production to employees have to be qualified, and more specifically when lean work practices are not supported by particular HRM practices such as training.

Third, this study is situated within the theoretical fields, which links work design and social performance (such as HPWS framework). As pointed out very recently by Kehoe and Wright (2013), very few studies investigate the important proximal links or mediating variable within the 'black box' of the HPWS framework. Our study illuminates the mediation via job satisfaction between lean work organization practices and intent to stay or health at work. In the same way, the relationship between HPWS and health at work are seldom studied (Böckerman et al. 2012). In testing the impact of a lean work organization practices bundle on health at work, we demonstrate that the health benefits of quality management are not sufficient to make up for the harmful effects of other lean work organization practices (broadened responsibilities, high standardization, job rotation, high problem-solving demand).

However, our study has a limitation. Using secondary data from a national survey (Sumer 2002-2003) constrained our choice of the indicators of measurement for our variables. Thus, the used survey does not enable us to study the effects of teamwork. Despite this limitation, the Sumer survey provides important guarantees about the internal and external validities of the results of our quantitative analysis.

From a practical point of view, the results of our research have important managerial implications. Indeed, our analysis shows that broadened responsibilities must be accompanied by a reinforcement of skills, since without these skills it becomes a source of tension. Similarly, job rotation cannot only be 'stopgap'; it must become a regular feature of employees' work and should be accompanied by multi-skilling, training and enhance their professional scope. Moreover, the quality procedures cannot simply be strict rules that individuals cannot enrich with their own practical experience. The creation of discussion forums in organizations would help management teams gain awareness about work quality as employees define it. Lastly, the hidden costs

associated with lean organization practices (employees' job dissatisfaction and intent to leave) could be lessened by reintroducing buffer stocks so as to enable the operator to regulate his/her work pace. As noticed by Vidal (2007b), the lack of buffers was an extremely common complaint among workers. The reintroduction of buffer stocks was the path chosen by Toyota in the early 1990s in order to fight against the growing costs of non-quality generated by high turnovers (Conti and Warner, 1997).

Before generalizing the lean production system to all service sectors (Hanna, 2007), it is necessary to first carry on more in-depth theoretical and empirical studies about lean production by mobilizing appropriate qualitative and quantitative methodologies using a multidisciplinary perspective. Furthermore, according to MacDuffie (1995: 198), "mass and flexible (or "lean") productions systems implicitly require different approaches to managing human resources." Indeed, the idea underlying the lean production model is that this form of work organization requires considerable discretion and problem-solving activities on the part of motivated and skilled employees (Lorenz and Valeyre, 2005; MacDuffie and Pil, 1997). Therefore, lean work organizations are more likely to be supported by particular HRM practices concerning training or pay (Lorenz and Valeyre, 2005). Actually, these last authors have showed that training and individual forms of pay were more widespread in lean work organizations. Consequently, the lack of HRM practices, e.g. training, in French lean organizations could explain the paradoxical poor effects of delegation of responsibilities and job rotation practices on employees' outcomes. However, we have not tested the effects of the specified HRM practices associated with lean work organization on employees' outcomes. Thus, it would be relevant to test how the HRM practices and social support, based on the Karasek and Theorell (1990) model, could moderate the relationship between lean work organization practices and employees'

outcomes. It would also be interesting to test a moderated mediation model between lean work organization practices and intent to stay using HRM practices as a moderator and job satisfaction as a mediator. Finally, in view of the very rare European national studies on lean employees' outcomes, it would be very interesting that research including lean work organization and HRM practices be carried out in other European countries so as to compare our findings in different national contexts.

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FIGURE

Figure 1. Hypothesized model of specific lean work organization practices on job satisfaction, intent to stay and health at work

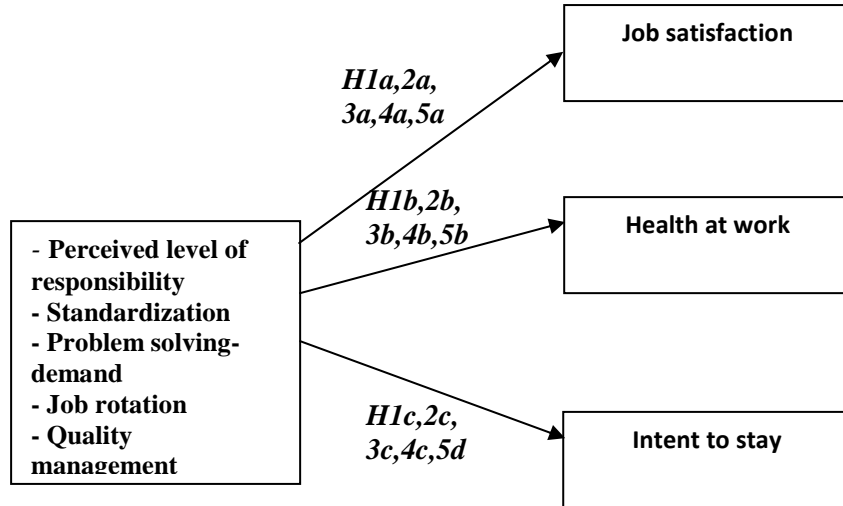


Figure 2a. Hypothesized model of a lean work organization practices bundle on job satisfaction, intent to stay and health at work

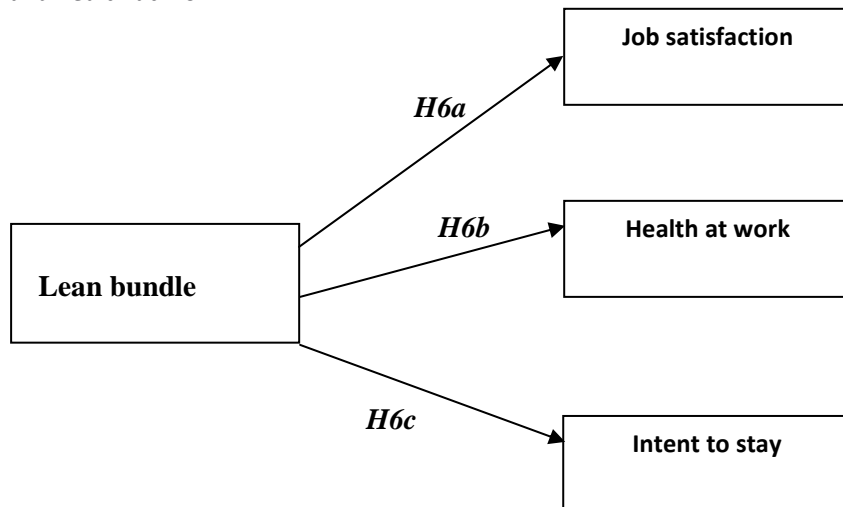
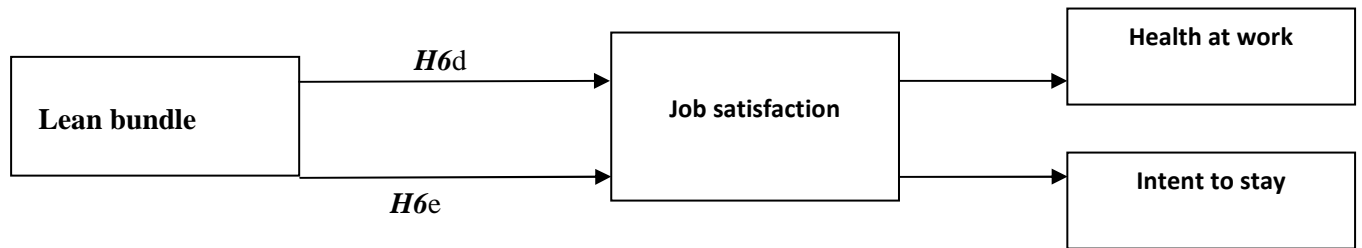


Figure 2b Hypothesized mediated model of a lean work organization practices bundle on job satisfaction, intent to stay and health at work



TABLE

Table 1. The association between the error term and independent variables in the hierarchical logistic ordinal regression on intent to stay

	1	2	3
1. Error term (\mathcal{E})	1.00		
2. Job satisfaction	.024**	1.00	
3. Lean bundle	.003	-.060**	1.00

Notes: Pearson’s correlation coefficients reported.

* $P < .05$

** $P < .01$

Table 2. The association between the error term and independent variables in the hierarchical logistic ordinal regression on health at work

	1	2	3
1. Error term (\mathcal{E})	1.00		
2. Job satisfaction	.191**	1.00	
3. Lean bundle	-.012	-.060**	1.00

Notes: Pearson's correlation coefficients reported.

* $P < .05$

** $P < .01$

Table 3. Bivariate correlations for all variables

	1	2	3	4	5	6	7	8	9
1. Responsibility	1.00								
2. Problem-solving demand	.020**	1.00							
3. Job rotation	.059**	-.023**	1.00						
4. Standardization	-.001	-.136***	.022***	1.00					
5. Quality management	.130**	.010	.024***	-.058***	1.00				
6. Lean bundle	.281***	.138***	.277***	.176***	.289***	1.00			
7. Intent to stay	-.044**	-.001	-.052**	-.035**	-.047**	-.047**	1.00		
8. Job satisfaction	-.039**	.003	-.035**	-.069**	-.070**	-.058**	-.291**	1.00	
9. Health at work	-.149**	-.054**	-.041**	-.018**	-.032**	-.063**	.188**	.258**	1.00

Notes: Kendall's tau-b correlation coefficients reported.

* $P < .05$

** $P < .01$

Table 4. Logistic ordinal regression (estimated parameters, marginal effects and Wald test) of the variables pertaining to lean work organization practices on job satisfaction, employees' intention to stay and health at work

Independent variable	Parameter estimate					
	Job satisfaction		Health at work		Intention to stay	
	β	p	β	p	β	p
Responsibility	-.131 (-7.214)	.000	-.535 (-0.167)	.000	-.108 (-.104)	.000
Problem-solving demand	.004 (-0.170)	.909	-.133 (-.237)	.000	-.058 (-.154)	.102
Job rotation	-.119 (-0.285)	.000	-.186 (-.237)	.000	-.191 (-.021)	.000
Standardization	-.321 (-0.285)	.000	-.202 (-.234)	.000	-.245 (-.131)	.000
Quality management	-.093 (-0.166)	.004	.065 (0.02)	.026	-.082 (-.048)	.014
Number of Observations	24486		24486		24486	
-2 Log likelihood	43078.593		59705.413		37409.800	
Chi-square	748.552		1435.394		1685.72	
d.f	22		22		22	

Notes: β values are unstandardized regression coefficients. p is the statistical significance. Marginal effects dy/dx at the medians are in parentheses (explanatory variables are set equal to their medians). Control variables: size of the organization, sector of activity, presence of a Committee for Health and Safety at Work (CHSW), type of working hours, sex, age, tenure, employment status and socio-professional category.

Table 5. Logistic ordinal regression (estimated parameters, marginal effects and Wald test) of lean bundle variable on job satisfaction, employees' intention to stay and health at work

Independent variable	Parameter estimate					
	Job satisfaction		Health at work		Intention to stay	
	β	P	β	p	β	p
Lean bundle	-.344 (-0.344)	.000	-.452 (-0.374)	.000	-.307 (-2.335)	.000
Number of Observations	24486		24486		24486	
-2 Log Likelihood	43275.997		60313.787		37573.410	
Chi-square	627.416		940.673		1624.666	
d.f	18		18		18	

Notes: β values are unstandardized regression coefficients. p is the statistical significance. Marginal effects dy/dx at the medians are in parentheses (explanatory variables are set equal to their medians). Control variables: size of the organization, sector of activity, presence of a Committee for Health and Safety at Work (CHSW), type of working hours, sex, age, tenure, employment status and socio-professional category.

Table 6. Hierarchical logistic ordinal regression (estimated parameters and Wald test) of lean bundle on employees' intention to stay and health at work

Independent variable	Parameter estimate							
	Intention to stay				Health at work			
	Model 1		Model 2		Model 1		Model 2	
	β	p	β	p	β	p	β	p
<i>Lean bundle</i>	-.307	.000	-.201	.000	-.452	.000	-.382	.000
Job satisfaction			1.248	.000			-.915	.000
Number of Observations	24486		24486		24486		24486	
-2 Log likelihood	37573.410		34969.700		60313.787		58719.904	
Chi-square	1624.666		4537.176		940.673		3131.033	
d.f	18		19		18		19	

Notes: β values are unstandardized regression coefficients. p is the statistical significance. Control variables: size of the organization, sector of activity, presence of a Committee for Health and Safety at Work (CHSW), type of working hours, sex, age, tenure, employment status and socio-professional category.

APPENDIX

The items used to measure the independent variable ‘level of responsibility’

- Level of responsibility. Items used:

1. Making a mistake at work can have serious consequences for me or the organization I work for.
2. Making a mistake at work can be financially costly for the organization I work for.
3. Making a mistake at work can have serious consequences for my safety or that of others.
4. Making a mistake at work may result in sanctions against myself (a drop in your remuneration, a change in job positions, creates a risk for your job).

Table 7. Logistic ordinal regression (estimated parameters and Wald test) of lean bundle variable on job satisfaction, employees' intention to stay and health at work

Independent variable	Parameter estimate					
	Job satisfaction		Health at work		Intention to stay	
	β	P	β	p	β	p
Control variables						
Sex						
Men	.005	.878	-.038	.183	-.192	.000
Women	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>
Socio-professional category						
White-collar workers	.321	.000	-.381	.000	-.255	.000
Middle-level managers	.016	.654	-.146	.000	-.227	.000
Clerks	-.025	.554	.085	.024	-.297	.000
Blue-collar workers	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>
Tenure	-.138	.000	-.169	.000	-.008	.674
Age	.000	.770	-.002	.138	.052	.000
Work Status						
Apprenticeship	.457	.000	.596	.000	.687	.000
Trainees	.169	.419	.666	.001	-.174	.406
Temporary work	-.309	.010	.550	.000	-.498	.000
Contract of limited duration	.379	.000	.441	.000	.042	.666
Contract of unlimited durations	.142	.012	.213	.000	-.114	.053
Civil servants	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>
Type of working hours						
Full time	.097	.021	-.240	.000	.000	.999
Part time	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>
Activity sector						
Industry	-.103	.002	.176	.000	-.052	.129
Construction	.232	.000	-.048	.391	.349	.000
Service	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>
Size of the organization	.000	.000	-.000	.000	.000	.841
Presence of a CHSW						
Yes	-.381	.000	-.060	.034	-.369	.000
No	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>

	Lean bundle					
Lean bundle	-.344	.000	-.452	.000	-.307	.000
Number of Observations		24486	24486		24486	
-2 Log Likelihood	43275.997		60313.787		37573.410	
Chi-square	627.416		940.673		1624.666	
d.f	18		18		18	

Notes: β values are unstandardized regression coefficients. p is the statistical significance.