Lean Working Environments – An Empirical Study of 24 Companies Implementing Lean

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Abstract

This paper studies the perceived effects on the working conditions in 24 medium sized manufacturing companies, approximately 1.5 year into their implementation of Lean. This is studied quantitatively based on four stakeholders' perceptions (the workers, the managers, the production supervisors and the white-collar workers), based on three factors; changes in the working environment, work with safety for the personnel and level of stress. The results indicate that the physical work environments have improved and the workers and production supervisors report a slight increase in stress. Lastly, all groups report an increase in the work with safety for the personnel.

Introduction

Lean Production is a Toyota-inspired management concept (Womack et al., 1991; Womack & Jones, 2003; Liker, 2004) which has, during the recent decade, become very popular in Sweden. There are also several Swedish "Lean success stories", such as Scania and Astra Zeneca, which, together with a growing Lean consulting industry, does its share in aiding of the popularity of Lean in Sweden.

Lean Mean Production

Although Lean today seems to be mostly viewed positively, at least in the popular media (even if there are still critics of the concept), this has not always been so. For instance, the concept was during the 1990s, sometimes described as being "mean", or "anorectic", by the critics - i.e. the argument was that Lean causes "mean" production systems which are bad for the employees' health.

For instance, several researchers have reported problems created by increased job intensity and higher demands, without increases in the positive aspects of work, such as a broadened set of work duties, work rotation, increase in team work, etc., when Lean has been implemented (Berggren, 1993; Björkman, 1996; Haynes, 1999; Landsbergis et al., 1999; Schouteten & Benders, 2004).

Of course, this does not stand unchallenged; for instance, Womack et al. (1991), Womack and Jones (2003) and Liker (2004) has argued that a true Lean production system will create better working conditions, through increase in team work, job rotation, increased skill level and broadened work responsibilities, etc. However, empirical research supporting this argument, i.e. that true Lean production systems creates positive working conditions, are scarce (Genaidy & Karwowski, 2003).

Adding to this is the observation made by some researchers that Lean might have "transformed" during the last decade, into a more participatory concept. For instance, Säppälä och Klemola (2004) in their studies of Finish companies implementing Lean, argue that the concept has taken on socio-technical structures. This, together with the observation made by Hampson (1999), that surrounding social factors (such as the union's power and means to implement their will) for an organizations determines if Lean becomes "mean" or not, means that it is of great interest to investigate empirically how Swedish companies today perceive that the working conditions are affected, when Lean is implemented.

Purpose of this Paper

The purpose of this paper is to examine empirically how 24 Swedish manufacturing companies perceive that the implementation of Lean Production affect several aspects of their working conditions, using a quantitative approach.

More specifically, in this paper, we will study how four stakeholders (workers, managers, production supervisors and white-collar workers) within these companies perceive that three aspects of their working conditions have changed 1.5 year into their implementation of Lean; the physical work environment, the work with safety for the personnel and the level of stress.

Method

The Companies in the Study

The 24 companies included in this study were all medium sized manufacturing companies, located in different geographical areas of Sweden. This meant that they all had between 50-250 employees, when they started their "Lean journey", and they were all focused on traditional manufacturing, although their market focus differed.

All of the companies have also been involved in a Swedish national development program, called Produktionslyftet (roughly translated into English as "the Production Lift"); for more information about the program, see www.produktionslyftet.se. This is a three year program, financed by the Knowledge Foundation ("KK-stiftelsen", in Swedish), VINNOVA and the Swedish Agency for Economic and Regional Growth ("Tillväxtverket", in Swedish), running during the period of 2007-2010.

The program has to date included 60 medium sized manufacturing companies, and is focused on supporting them during approximately a 1.5 year period, in their implementation of Lean. This, through an extensive program of consulting and educational support, focusing both on the philosophical and technical aspects of Lean, such as the tools associated with Lean (5S, improvement groups, value stream mapping, SMED, visualization, etc.); most companies have worked mostly with 5S and improvement groups.

The Questionnaire Study

The questionnaire questions, presented in this paper, are part of a larger questionnaire send out to the companies of Produktionslyftet, which is part of a larger research project, connected to the program. For instance, a qualitative process study has also been performed with the pilot companies of the program, although no results from that study will be presented in this paper.

The questionnaire is sent out to the companies after they have finished their time in the program, i.e. roughly 1.5 year into their Lean implementation. The questionnaire is extensive, although only part of the collected empirical data has been included in the analysis done in this paper. These questions are three statements intended on assessing how the respondents disagrees or concurs to the following statements, regarding perceived *changes during the recent year*:

1) The physical working environment ("arbetsmiljö", in Swedish) has improved.
2) The work with safety for the personnel has increased.
3) The level of stress has increased.

The instruction, to the companies, was that those who had been actively involved in the Lean implementation, together with the company management group and representatives of the blue and white collar union, was the intended target for the questionnaire. However, which these persons actually where, for each individual company, was determined by the companies themselves.

Concerning the questions regarding how the working conditions have been affected, during the last year, answers from four groups/stakeholders have been included in this paper; the operative personnel ("workers"), the production supervisors, white-collar workers, and the managers of the companies. These results will be presented separately, i.e. group for group, in order to analyze if there are differences between how these stakeholders perceive that the working conditions have changed during the last year. A medium value significance test (Rudberg, 1993) will also be performed, to see if there are significant differences between how these groups perceive these issues.

Number of Respondents

In total, the number of persons answering the three questions was 282. Broken down into the four different groups, this means that 85 managers, 51 production supervisors, 99 workers and 47 white-collar workers have answered these questions.

The Weighing of the Answers

Five categories were used, as possible answers to statements (1)-(3); "concurs strongly", "concurs", "disagrees", "disagrees strongly" and "don't know". These data were broken down into four categories; answers from managers, production supervisors, operative personnel ("workers") and white-collar workers. The formula below was used to weigh the answers from the respondent groups, resulting in a single number ranging between -2 and 2, for each statement and each group:

Formula 1: Weighing of the answers

$$W_{a,b} = \frac{2n_{A,b} + n_{B,b} - n_{C,b} - 2n_{D,b} + 0n_{E,b}}{n_{tot,b}}$$

$W_{a,b}$ is the weighing for statement a, for group b, and $n_{A,b}$ are the number of persons concurring strongly with the statement, for group b, $n_{B,b}$ are those concurring for group b, n_C those disagreeing, n_D those disagreeing strongly and n_E the number of persons who do not know. $n_{tot,b}$ is the total number of persons, for group b, answering the question (i.e. $n_{A,b} + n_{B,b} + \ldots + n_{E,b}$).

Also, a medium value difference significance test (Rudberg, 1993) was performed, in order to analyze if there is a significant difference between how the groups perceive these changes.

Results

The following figures below (figure 1-3) show the results from these studies and in table 1 the results of the significance tests are presented.

Regarding the changes in the physical working conditions (figure1, below), the managers and white-collar workers present the most positive perspective of the changes, meaning they concur to the highest degree that the physical working environment have improved. Those who concur to the lowest degree are the production supervisors. In fact, the data show that there is a statistical significant difference between the managers and the workers (5% insecurity), and also between the production supervisors and managers (1% insecurity), although not between the production supervisors and operators and no difference between the white-collar workers and the managers.

The managers and white-collar workers are the most positive when it comes to the issue of work with safety for the personnel (see figure 2), followed by the workers and the production supervisors; however, no statistically significant differences between the four groups can be identified, suggesting some level of consensus between the groups.

Lastly, regarding how the respondents perceive that the stress has changed (figure 3), during the last year, we again see a difference between the four groups. The managers and white-collar workers concur to the lowest degree to the statement that the stress has increased; in fact, they disagree with the statement. However, both the production supervisors and operators concur, albeit to a low degree. There is also a statistically significant difference between the managers and the production supervisors and workers (1% insecurity), although no statistically significant difference can be detected between the production supervisors and the operators, nor between the white-collar workers and managers.

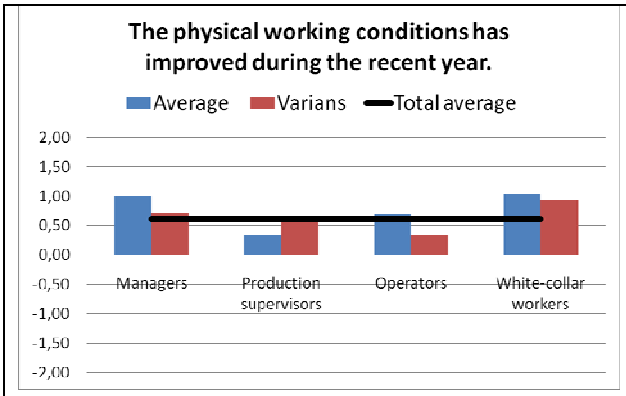

Figure 1: Physical working environment

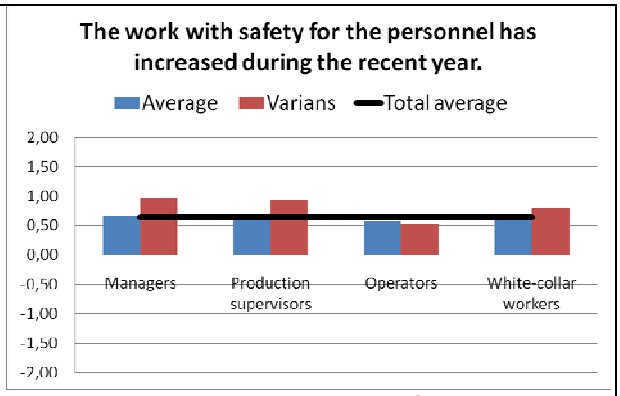

Figure 2: Work with safety

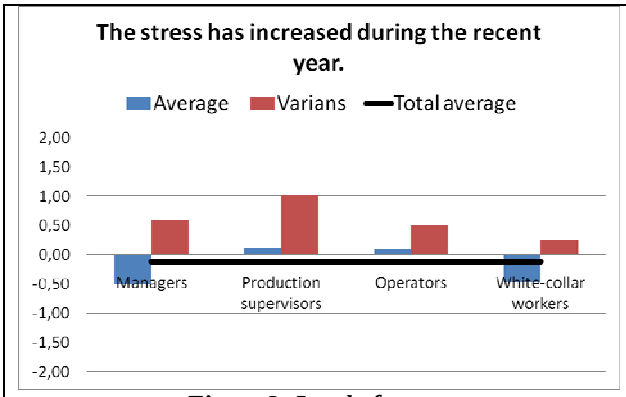

Figure 3: Level of stress

Table 1: Significance test for group differences between perceived effects on working conditions

Groups	PWC	LSW	LOS
M vs. PS	4,746	0,409	3,807
M vs. W	2,693	0,644	5,603
M vs. WW	0,253	0,131	0,336
PS vs. W	3,077	0,081	0,041
PS vs. WW	4,008	0,492	3,675
W vs. WW	2,193	0,704	5,597

PWC: Physical working conditions; **LSW:** Level of safety work; **LOS:** Level of Stress; **M:** Managers; **PS:** Production Supervisors; **W:** Workers; **WW:** White-collar workers

Discussion

Firstly, a methodological issue needs to be discussed, which is the question how the managers and white-collar workers have perceived the questions regarding how the physical work environment has changed, and also, the question regarding the stress; have they answered how they perceive changes in their own physical work environment and stress, or regarding how they perceive that the physical work environment and stress has changed for the workers and production supervisors – i.e. within the production facilities? Based on impression during other studies with the ten pilot companies of the program (i.e. the qualitative process study, mentioned earlier), the likely answer is that at least the managers have answered how they perceive that the conditions for the workers have changed.

Second, regarding the results concerning the changes in the physical working environment; here, the managers and white-collar workers of the companies clearly present the most positive perspective. However, a majority of the respondents, in all of the groups, still seems to perceive that the physical working environment have improved during the last year, i.e. during the implementation of Lean. This, together with the observation that most companies have focused a lot of energy on the work with 5S, suggests that the perceived changes reflect an increase in the order and cleanliness of the work place – i.e. these types of Lean tools have likely affected the perception of the work environment.

This trend, however, i.e. that the managers and white-collar workers of the companies are the most positive groups of the respondents in the companies, we can also observe regarding how the respondents concurs to the statement that the work with safety for the personnel has increased during the last year. However, the differences between the groups are much smaller here. Thus, since a majority of the respondents in the companies agrees that the work with safety has increased (with small differences between the four groups), this suggest that work with safety has increased. Why this is so, the data does not tell us, however.

Lastly, regarding the perceptions of the changes in stress during the last year, we see an interesting difference. The managers and white-collar workers do not agree with this statement; however, the workers and production supervisors concur to some degree, although only slightly. Of course, from these data, it is difficult to assess what causes these differences. One possible interpretation is that the recession of 2008-2009 has affected the employees, through layoffs and similar activities, to a higher degree than the managers, creating a higher level of stress. Of course, this argument could also be reversed, i.e. one could argue that the stress has increased *despite* less to do for the workers in the production (due to the recession), and thus arguing that this a signal that the stress has in fact increased, and would have increased more if the recession had not lowered the amount of work in the production. However, a third possible interpretation of the results is that the managers and white-collar workers of the companies would be less directly affected by work intensification in the production, if an intensification has occurred. Thus, although the data does not clearly show us which is the case, for these companies, it does not seems unreasonable to assume that some level of work intensification (i.e. stress) has occurred for the workers and production supervisors, although at this point, it is difficult to assess precisely *why* this has occurred. Also, from these data, it is not possible to tell how this affects the health of the employees.

Conclusions

Several interesting conclusions are plausible, from the results presented here. First of all, the four different groups perceive differently how the working environment have changed during the last year; the managers and white-collar workers are, to a large extent, the most positive, while the operators are positive, but significantly less than the managers and the white-collar workers, which is also the case for the production supervisors, which are the least positive, although still positive. Second, there is some evidence in these results that the production supervisors and workers perceive some degree of work intensification, since their perceived stress has increased during the last year, although to a low degree. However, the managers and white-collar workers of the companies do not perceive such an increase in stress. Thirdly, regarding the work with safety, here all the groups are in consensus; the conclusion is that the safety work has increased, to some degree, for the personnel.

Thus, the conclusion from these results is that the implementation of Lean, in these 24 companies, has meant some improvements in the physical work environment and a small degree of work intensification – but mostly, it does seem to mean an increase in work with safety for the personnel.

References

Berggren, C. (1993). Lean Production: The End of History?, *Work, Employment & Society* (vol. 7, no. 2)

Björkman, T. (1996). The Rationalization Movement in perspective and some ergonomic implications, *Applied Ergonomics* (vol. 2, no. 2, p. 111-117)

Genaidy, M. A., Karwowski, W. (2003). Human Performance in Lean Production Environment: Critical Assessment and Research Framework, *Human Factors and Ergonomics in Manufacturing* (vol. 13, p. 317-330)

Hampson, I. (1999). Lean Production and the Toyota Production System, or the Case of the Forgotten Production Concepts, *Economic and Industrial Democracy,* (vol. 20, p. 369-391)

Haynes, A. (1999). Effects of world class manufacturing on shop floor workers, *Journal of Industrial Training* (1999-06-23, p. 300-309)

Liker, J. (2004). *The Toyota Way*, McGraw-Hill

Rudberg, B. (1993). *Statistik*, Studentlitteratur AB

Schouteten, R., Benders, J. (2004). Lean Production Assessed by Karasek's Job Demand-Job Control Model, *Economic and Industrial Democracy* (vol. 25, p. 347-373)

Seppälä, P., Klemola, S. (2004). How Do Employees Perceive Their Organization and Job When Companies Adopt Principles of Lean production?, *Human Factors and Ergonomics in Manufacturing* (vol. 14, no. 2)

Womack, J., Roos, D., Jones, D. T. (1991). *The Machine That Changed the World – The Story of Lean Productun*, Harper Pernnial

Womack, J., Jones., D. T. (2003). *Lean thinking*, Free Press