# Lean production and work-related musculoskeletal disorders: overviews of international and Swedish studies

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Abstract. This paper aimed at summarizing the knowledge of the relationship between Lean and work related musculoskeletal disorders (WMSD), and WMSD risk factors, in manufacturing companies. Literature search processes identified 23 publications studying this, in scientific journals. Eight included measurements of WMSD; three were mostly negative, two showed mixed results, one showed no results and two were mostly positive. Eighteen publications included measurements of WMSD risk factors; seven showed mostly negative results, eight snowed mixed results, two showed mostly positive results and one was inconclusive. Three literature reviews were identified, which studied this question; two were mostly negative, while the third was inconclusive. Also, 12 publications of grey literature studying Lean and WMSD risk factors in Swedish organizations were identified; nine showed mixed results, two showed mostly positive results. Due to the varying quality and study design of the publications, together with the few identified studies, it is difficult to compare them. The context and the implementation also likely affect the results. The general conclusion was that a Lean implementation may increase the risk of WMSD and risk factors for WMSD, if it is not accompanied with an ergonomic intervention.

Keywords: WMSD, working conditions, manufacturing

#### 1. Introduction

Lean Production is currently the dominating rationalization concept in the manufacturing industry in Sweden[1-2]. Due to the fast spread of Lean, it is important to study the effects of Lean on work related musculoskeletal disorders (WMSD) and potential risk factors for WMSD, especially since assembly workers in general has a high risk of developing WMSD.

The Swedish context is of special interest for this study, due to the socio-technical tradition that has been influential in the Scandinavian countries, to-gether with a strong union presence and legislation regarding work conditions[2]. These factors likely affect how Swedish companies work with Lean and how the concept affects the employees[3].

#### 1.1. Lean production

Lean Production as a management concept was introduced to a wider public through the book *The Machine that Changed the World*[4]. The concept was not new; earlier publications existed, but through this book, the concept received a large impact[5].

There is no unified definition of Lean[6] and different researchers focus on different aspects of the concept. However, techniques which are often included in Lean's operationalization are small-sized batches (Just in Time-production), 5S/housekeeping, waste reduction (muda), production balancing (jidoka), kanban, standardization, reduction of set-up times and continuous improvements[6].

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#### 1.2. Aim of the study

The aim of the study was to create an overview of the scientific knowledge concerning the relationship between Lean Production (and similar production system designs) and WMSD/risk factors for WMSD. The focus was on manufacturing companies.

A separate search was also made, with the aim of studying how Swedish organizations' work with Lean affects employees.

#### 2. Method

Literature searches were performed in Ergonomics Abstract, Pubmed and Business Source Elite<sup>1</sup>. The identified publications references lists were used to find more publications. The search was limited to English and Swedish publications, published after 1980. Conceptual and theoretical papers have been excluded. Studies from non-manufacturing contexts or studies which only focused on specific Lean tools were excluded from the results. Also, studies of Total Quality Management/TQM were excluded, since TQM and Lean are significantly different[6]. However, studies of the Toyota Production System/TPS, Just in Time-philosophy and JiT-manufacturing were included in the results, due to the similarities between TPS and Lean, and since JiT was determined to be an often reoccurring part of Lean.

No excluding definition of Lean has been used during the search process, due to the lack of a unifying definition of the concept. Neither has any means of measuring level of Lean implementation been used, for the same reasons. In order to determine which risk factors that affect mechanical exposure, and consequently, increases the risk for WMSD, Westgaard and Winkel's definition was used[7].

No quality measurement model has been use to assess and rank the identified publications in the search, depending on such factors as study design, etc.

During the search, three literature reviews[7-9] were also identified, which studied directly or indirectly the relationship between Lean and employee effects. Other researchers have also contributed with publications of significance for this overview, which were not identified by the search engines or included in the reference lists of the identified publications.

Since no publications in scientific journals were detected, which studied the relationship between WMSD and Lean in the Swedish manufacturing industry, the choice was made to expand the search to grey literature (conference publications, consultant and union reports, student thesis and dissertations, etc.). This decision was based on Eklund et al.'s[10] argumentation to use the best knowledge available.

### 3. Results

The search process resulted in 23 publications in scientific journals (not including the publications describing Swedish organizations work with Lean). These are presented in table 1. The few identified papers, together with the differences between the studies, meant that no meta-analysis was possible. The included studies were of varying quality and the Lean interventions were seldom described in detail, making comparisons difficult.

Of the identified publications, eight included measurements regarding WMSD; three showed mostly negative results, two showed mixed results, one showed positive results and two showed no differences between Lean and non-Lean companies. 18 of the found publications studied relevant risk factors for WMSD. Of these, seven showed mostly negative results, eight showed mixed results, two showed positive results and one showed inconclusive results.

Three literature reviews were identified, which studied the relationship between Lean and employee effects[7-9]. Two of these showed mostly negative views of Lean's effects on employee, while one gave an inconclusive view.

The search for publications describing the relationship between Lean and employee effects in Swedish companies resulted in 12 publications (mostly grey literature). Of these, nine showed mixed results, two showed mostly positive results and one showed mostly negative results. Only one publication contained measurements of WMSD frequencies, comparing Lean to non-Lean companies; it showed an increased risk for WMSD in Lean companies, especially for women. However, one of the found publications contained results from non-manufacturing organizations.

When comparing included positive and negative employee results in the Swedish and non-Swedish publications, the ratio between them in the Swedish studies were more even; in the non-Swedish studies, the negative results were more common.

<sup>&</sup>lt;sup>1</sup> Used search words are available on request.

#### 4. Discussion

Given the small number of studies, together with their varying quality and study design, and often insufficient descriptions of the Lean interventions, there is not enough basis to make decisive conclusions regarding the connection between Lean and WMSD. However, tentative conclusions were made regarding emerging *tendencies* in the found publications.

The results shows a tendency for increasing the risk of WMSD, when Lean is implemented, especially if the implementation is not accompanied by an ergonomic intervention program, focused on addressing issues such as reducing monotony and repetitiveness of work.

When it comes to risk factors for WMSD, the results shows that Lean appears to have a tendency to lead to increased work pace, workload, work intensification and stress. However, Lean often, though not always, seem to create positive effects for the employees as well. Consequently, this seems to be in line with Berggren's[11] conclusion, that Lean means worker smarter *and* harder, not just smarter.

The results from the publications describing employee effects from Swedish companies also shows mixed results, though with a majority of positive effects, at least concerning risk factors for WMSD. However, the grey nature of the studies, together with the low number of publications, means that conclusions from them should be tentative, at best. There is little direct information concerning WMSD, meaning that no conclusions are merited from the publications.

The tendency towards more positive results from Lean, could possibly be explained by the Swedish socio-technical context[3] and a high level of employee participation in the companies' Lean implementations. Also, Saurin and Ferreira's[12] argumentation, that a Lean system which is not fully in place allows for more worker autonomy, which could reduce some of the negative aspects of the Lean, could apply here. The reason is because many of the studied Swedish companies have only implemented some aspects of Lean.

#### References

 Börnfelt, P.-O., Förändringskompetens på industrigolvet: kontinuerligt förändringsarbete i gränslandet mellan lean production och socioteknisk arbetsorganisation, in Lastly, we need to keep in mind, as Hasle et al.[8] and Landsbergis et al.'s[9] argue, the importance of how the implementation and context affects the employee results from Lean. Consequently, it is difficult to assess how much of the results that are caused by these factors. Based on this, we argue that it is important to monitor the Lean implementation effects on the employees, in order to reduce problems and capture positive effects.

#### 5. Conclusions

While Lean can lead to both positive and negative effects for employees, there is insufficient amount of studies, and they are of varying quality and study design, to make decisive conclusions. Nevertheless, negative results are more frequently reported in the non-Swedish studies, when compared to the grey literature describing studies in Swedish organizations. Thus, it is merited to *tentatively* conclude that without active ergonomic interventions, the introduction of Lean in a manufacturing setting can create an increased risk for work-related musculoskeletal disorders, though the risk of this in Swedish companies might be lower. However, future research is needed to better understand the relationship between Lean Production and WMSD, both in Swedish and non-Swedish organizations.

#### 6. Limitations

The result of the literature searches does not pretense to be covering all existing publications of Lean and WMSD, especially not psychological risk factors.

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#### Table 1

Identified studies describing found relationship between Lean and WMSD, and between Lean and risk factors for WMSD. (+) = high, increasing; (+?) = weak positive connection; (-) = decreasing, low; (-?) = weak negative connection; (+/-) = both increasing and decreasing:  $(0) = n_0$  affective connection. The studies are presented in characteristical order, starting with the most event ones.

decreasing, (0) – no criced	The st	and a surface of the starting with the most recent ones.
Author, year, industry, study	Effects on	Effects on risk factors for WMSD
design, studied change	WMSD & health	
Saurin & Ferreira 2009[12]	Pain/discomfort at	Increased work pace/load (+)
Manufacturing of harvesters,	a moderate level;	Decreased time for brakes (-).
Brazil, interviews, question-	unchanged by	Increased pressure from superiors to achieve goals; still, the employees were
naires, feedback meeting, no	Lean (0).	fairly satisfied with the relationship with the managers (+)
control group, several Lean tools		General working conditions had improved (+)
implemented since 2001.		Moderately stressed, which had increased from Lean (+)
I · · · · · · · · · · · · · · · · · · ·		Improved autonomy (+)
Womack et al. 2009[13]	The Lean factory	Repetitive work increased (+)
Car manufacturing USA Com-	had reduced the	Lower use of force (-)
car manufacturing, USA. Com-	nau reduced the	No difference in week negtures (0)
parison between 56 work stations	humber of injuries	No difference in work postures (0) In hath factories $(00)$ of the second seco
in a Lean & traditional factory.	by 19% between	in both factories, 60% of the work was classified as having risk for hand related
	2000-2006 (-).	problems; no significant differences between the two factories.
Brown & O'Rourke 2007[14]		Increased pressure on the production (+)
Shoe manufacturing, China. Case		Increased individual stress (+)
study: 27 questionnaires & focus		Almost all of the respondents reported that the work conditions had improved
groups (20 persons), no control		during the recent year. (+)
group. Lean was introduced		Stress was related to worry of not reaching set goals, unrealistic goal setting, too
approximately 1 year ago; used		high work pace, too much work, unfair supervisor
tools was JiT, reduced invento-		
ries. etc.		
Conti et al. 2006[15]		Reversed u-shaped connection between stress and level of Lean implementation:
Manufacturing UK 1391 ques-		low level of Lean increased stress, while reduced stress at high level of imple-
tionnaires assessed level of Lean		mentation of Lean( $+/-$ )
(1.5) for 10 Lean tools & tosted		The stress is increased by work intensification, exertime, doing the work for
(1-5) for to Lean tools & tested		The success is increased by work intensification, overtime, doing the work for
21 hypothesis related to stress.		personnel missing for sick leave, lack of tools, ergonomic difficulties and sname
		for defect products; stress was reduced through participation, teamwork and
		support in the work situation.
Mehri 2005[16]		Perceived work load was high (+)
Car manufacturing, Japan, for-		
mer employee of studied compa-		
ny. 75 interviews.		
Brenner et al. 2004[17]	Correlation be-	
Fairis & Brenner 2001 [18]	tween cumulative	
Industrial setting, statistics from	trauma disord-	
BLS, combined with investiga-	ers/CTD and	
tion of the occurrence of TOM	Quality Cir-	
IT teams and Quality Circles	cles/OC and	
sir, teams and Quanty Choles.	hetween CTDS &	
	$FT(\pm)$ : worse	
	JII (+); worse	

	when JiT & QC	
	was combined (+).	
	No connection	
	between CTD &	
	TQM, & between	
	CTD &  team.  (0)	
Schouten & Benders 2004[19]	Workers:	Workers:
Observations and 63 employee	rew problems	Autonomy limited (-) Support from supervisors or other departments had decreased ()
questionnaires used tools were	ical reactions (-)	High dissatisfaction with work content (-)
JiT. quality control. TPM, stan-	icul icucións ( )	Short work cycles (-)
dardization, 5S, andon, kaizen		Overview of work limited (-)
and reduced inventories.		Need for resting high (+)
		Satisfactory means to solve problems in work, due to support from workers (+)
		Work satisfaction limited (-)
		Supervisors:
Sannälä & Klamala 2004[20]		Better working conditions, when compared to workers (+)
Manufacturing companies Fin-		Increased perceived work control (+)
land Cross-sectional study 525		Increased stress for the white-collar workers (+)
questionnaires.4 companies.		
introduced Lean tools were JiT,		
"pull" production, etc.		
Parker 2003[21]		Work related depression increased with assembly lines and standardization (+)
Automotive manufacturer, UK.		Reduced confidence to own ability to perform a broader role, such as making
368 questionnaires, 3 years after		suggestions for improvements (-)
Lean was implemented. Control		Worker involvement in the workplace was reduced (-)
tools: assembly lines Lean		increased for the employees in the technical support group (+)
teams process development		No changes in workload or work related worry for lean team (0): increased for
teams, standardization, reduced		assembly lines (+).
inventories, "pull-production",		Reduced participation in the work process and usage of skills, and reduced
manufacturability. The assem-		autonomy, were contributing factors for negative effects from Lean.
blers in the assembly line were		
not included in the Lean teams.		
Andersen-Connolly et al.		Employees:
2002[22] Manufacturing USA Longitu		Reduced health related to work intensity, competence and teamwork (-).
dinal questionnaire study (1997		Management:
& 1999), 1244 questionnaires.		Reduced health related to work intensity and autonomy (-).
Studying effects from restructur-		Improved health related to teamwork and work skill (+).
ing, outsourcing, reduced inven-		
tories, simplified processes &		
cross-functional teams.		
Bruno & Jordan 2002[23]		The perceived work environment and job satisfaction was reduced (-)
Car manufacturing (Chrysler),		Most of the employees felt that quality circles & teamwork gave very little (0).
& 1997) Lean tools imple-		nowever, difficult to assess if the changes are caused by Lean of other factors, such as distrust of the management or failed expectations on the work
mented: quality circles team-		such as distrust of the management of failed expectations on the work.
work, kaizen and andon.		
Lewchuk & Robertson	Working with	Perceived work pace higher at GM (+)
<b>2001</b> [24]	pain, exposure to	Highest perceived work load at GM (+)
Lewchuk & Robertson	muscular fatigue	Possibility of varying work rhythm and talking during the work was lowest at
1997[25]	& WMSD (+?)	GM, highest at CAMI (+/-)
Car manufacturing companies,		Difficulty of finding replacement for bathroom brakes were approximately the
of differing level of Lean impla		same (0)
mentation Highest level had GM		
& CAMI: lowest had Ford &		
Chrysler. 2424 questionnaire.		
Jackson & Mullarkey 2000[26]		Job satisfaction unchanged (0)
Garment manufacture. Compar-		Work related effort unchanged (0)
ing normal production line & cell		
manufacturing.		
Leclerc et al. 1998[27]	Odds ratio 2,24	

Assorted manufacturing compa-	for developing	
nies, France. Cross-sectional	CTD in compa-	
study of JiT-production, with	nies working with	
reference group	JiT (+).	
Adler et al. 1997[28]	High frequency of	
Car manufacturing (NUMMI),	reported injuries	
USA. Longitudinal case study,	during launch of	
investigating the ergonomic	car model (+).	
situation during launches of new	Injuries reduced	
car models in 1993 and 1995.	after ergonomic	
	intervention pro-	
	gram (-).	
Lewchuk & Robertson	Working with	Perceived work load higher, and the perceived increase was higher, when com-
<b>1996</b> [29]	pain similar in	paring the Lean companies to the traditional companies (+)
16 suppliers to car manufacturing	Lean & traditional	Perceived work load and uncomfortable working postures was lower in compa-
companies, Canada. 2 Lean	companies (0).	nies initiating Lean compared to traditional companies; the perceived increase in
companies, 4 companies who had	Working with	work load was also lower (-)
initiated Lean, 8 traditional com-	pain lower at	Uncomfortable work postures, fatigue after work and tension during work was
panies & 2 explorative compa-	companies initiat-	similar in Lean & traditional companies (0); however, the perceived increase of
nies. 1670 questionnaires	ing Lean (-)	fatigue after work and tension during work was higher in the Lean company (+)
Jackson & Martin 1996[30]		Work load higher with JiT (+)
Electronics manufacturing, UK		Work satisfaction decreased with JiT (-)
Comparison between JiT assem-		Psychological stress unchanged (0)
bly line (small batches, job rota-		Chance of influencing work pace and which order in which job task are done in
tion, simplified processes, pull		the work process decreased with JiT (-)
production, inspection of own		
work) & traditional non-JiT line.		
44 questionnaires before & after.		
Nielsen 1996[31]		Few or no changes in competence requirements (0)
6 manufacturing companies, 1 in		Integration of quality control in the normal job design was perceived as creating
process industry, Denmark		better job satisfaction (+)
Studied production systems		No changes in worker autonomy, though in one company, the autonomy in-
inspired by Japanese manage-		creased since workers could see the production planning one month ahead,
ment (sporadic implementation		instead of only 1-2 weeks (0)
of JiT, other Lean tools in parts		Physical work load unchanged (0)
of the factories). Interviews with		The general conclusion was that those jobs who had the best working conditions
persons from all levels of com-		from the start perceived some improvements (+), while it was unchanged in the
panies, observations from 3		jobs with repetitive and unqualified jobs (0).
companies, 150 questionnaires		The results and basis for the conclusions were not clearly presented in the paper.
from 4 companies		
Stewart & Garrahan 1995[32]		Physical fatigue from work increased (+)
Car manufacturers, USA & UK		Mental fatigue from work increased (+)
4 factories; 140 questionnaires.		Job satisfaction unchanged, or slight decrease (0/-)
Used tools: teamwork, conti-		
nuous improvements, etc.		
Mullarkey et al. 1995[33]		Stress showed no connection to JiT (0)
Electronics manufacturing, UK		Work satisfaction increased with JiT (+)
Prospective study of JiT & TQM.		Work pace/demands had a weak reversed connection with JiT (-?)
Babson 1993[34]		Perceived work demands increased (+)
Car manufacturing (Mazda &		Perceived work control decreased (-)
Ford), USA. Case study, 2380		A high proportion of the respondents believed that they would be injured/worn
questionnaires 3 years after Lean		out before pension, with the current work intensity (+)
implemented. No control group.		

#### Table 2

Identified studies describing the relationship between Lean and risk factors for WMSD in Swedish companies. (+) = high, increasing; (+?) = weak positive connection; (-) = decreasing, low; (-?) = weak negative connection; (+/-) = both increasing and decreasing; (0) = no effect/no connection. The studies are presented in chronological order, starting with the most recent ones.

Author, year, type of publi- cation, study design, studied change	Effects on WMSD & health	Effects on risk factors for WMSD
Berglund 2010[35]		Increased job satisfaction, through employee involvement in work with conti-
Dissertation. Qualitative study,		nuous improvements (CI) and problem solving (PS) (+)
3 companies working with		Reduced job satisfaction, due to increased control and steering of the work (-)
Lean.		Reduced cycle times ()

## M. Brännmark and M. Håkansson / Overviews of International and Swedish Studies

Brannark 2010[36]       Improved working environment (+)         Conference paper, Quilitative study (4) inter- views, 82, questionarize), 8       Improved work environment (+)         Outbuik & Obson 2010[37]       Improved work environment (+)         Conference paper, Quilitative study (14) inter- views, 82, questionarize), 8       Improved work environment (+)         Conference paper, Quilitative study (15)       Improved work environment (+)         Anderson & Lifjenvald       Increased stress due to more monotoous and stressful work (+)         Reduced job satisfaction, through employee involvement in C1 & PS (+)       Increased stress due to more monotoous and stressful work (+)         Reduced job satisfaction, through mersed group autonomy and employees       Increased stress due to more monotoous and stressful work (+)         Reduced job satisfaction, through increased group autonomy and employee empowerment, is common aspects in Swedish medium sized manufacturing companies inplement- ing Lean. Lean-tools. daily stressful work, with Lean (+?)         Patterson 2008[39]       Improved working environment (+)         Conference paper, Quilitative study, 2 companies implement- ing Lean, Lean-tools. daily stressful working environment (+)       Improved working environment (+)         Increased yob satisfaction, thoragh employee involvement in C1 & PS (+)       Increased work page (+)         Reduced poly satisfaction, through employee involvement in C1 & PS (+)       Increased work with lean (+2)         Conference paper, Quilitative	Brainmark 200(36)       Improved Working environment (*)         Conference paper, Qualitative study (41 inter-view, 52 questionaries), 83       Increased stress (*)         Weiss, 52 questionaries, 12 and tools value status, 51 more study (51 inter-view), 52 questionaries (*)       Increased stress (*)         Summark 200(35)       Improved work environment (*)         Conference paper, Qualitative cases study of Tage company implementing Lean.       Improved work environment (*)         Reduced (20 statisfiction, through employee involvement in CL & PS (*)       Increased stress due to more monotonus and stressful work (*)         Reduced (20 statisfiction, through employee involvement in CL & PS (*)       Increased stress due to more monotonus and stressful work (*)         Reduced (20 statisfiction, through employee involvement in CL & PS (*)       Increased stress due to an ennotonous and stressful work (*)         Reduced (20 statisfiction, through increased group autonony and employee compowerment, is common aspect in Sweddish medium sized manufacturing companies' lean work.       Intervest work with Lean (*?)         Reduced (20 statisfiction, florogate particle partin particle particle particle particle particle parting particle p	D		<b>T 1 1 1 1 1 1 1 1 1 1</b>
Contence paper. Qualitative & quantitative study (41 inter-views, 82 quastionnaires), 8       Increased stress (+)         examative study (41 inter-views, 82 quastionnaires), 8       Improved work environment (+)         comparies. Lean tools: value stream mapping. standardization, 55, improvement groups and the stream mapping. standardization, 60, 50, 50, 500, 2010 (37)       Improved work environment (+)         Conterence paper. Qualitative case study of large company implement factors (+)       Reduced cycle times (-)       Reduced cycle standardization making work more boring (-)         Anderson & Liljenvald       Improved work environment (+)       Reduced cycle standardization making work more boring (-)         Student thesis. Questionnaire study of common clements in somono aspects in Swedish medium sized manufacturing companies work with Lean (+?)       Reduced cycle standardization making work more boring (-)         Retirence paper. Qualitative study. Companies implementing (-ani, Lean-ools: daily steering, visabilingtion & S.S.       Improved work environment (+)         Conference paper. Qualitative study. Companies implementing (-ani, Lean-ools: daily steering, visabilingtion & S.S.       Improved work environment (+)         Returnet 2009[39]       Improved work environment (+)       Improved work environment (+)         Returnet A env lift muck manufacturing environment (+)       Improved work environment (+)         Returnet A environment Harve A one lift muck manufacturing environment (+)       Reduced cycle times (-)         Returnet A one lift muck manuf	Conference paper. Qualitative & quantitative starts (+) k q quantitative starts (+) k q quantitative starts (+) k q quantitative starts (+) k q q q q q q q q q q q q q q q q q q q	Brannmark 2010[36]		Improved working environment (+)
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<ul> <li>views, 82 questionnaires), 8 companies. Lean tools: value stream mapping, standardiza- tion, 55, improvement groups &amp; set-up time reduction.</li> <li><b>Oudhuis &amp; Obson 2010</b>[37]</li> <li>Improved work environment (+)</li> <li>Increased job satisfaction, through employee involvement in CL &amp; PS (+) Increased glob satisfaction, through employee involvement in CL &amp; PS (+) Increased vorkload, due to increased demands for working overtime (+)</li> <li><b>Anderson &amp; Lijenvald</b></li> <li><b>Conference paper</b>, Qualitative study of common elements in manufacturing companies' Lean work.</li> <li><b>Pettersen 2008</b>[39]</li> <li>Conference paper, Qualitative study, 2 companies implement- ing Lean. Constructions in the standardization making work more boring (-) funcreased vorkload, due to increased group autonomy and employce enopowerment, is common sapects in Swedish medium sized manufacturing companies work with Lean (+?)</li> <li><b>Network</b></li> <li><b>Pettersen 2008</b>[39]</li> <li>Conference paper, Qualitative study, 2 companies implement- ing Lean. Londox: daily steering, visualization &amp; S.S.</li> <li><b>Ekind &amp; Bergund 2007</b>[40]</li> <li>Improved working environment (+)</li> <li>Increased stress, caused by more monotonous work, assembly lines and in- creased workload, due to slower and more even work pace (+) Increased stress, caused by more monotonous work, assembly lines and in- creased workload, due to slower and more even work pace (-) Increased vorkload, due to slower and more even work pace (-) Increased vorkload, due to slower and more even work pace (-) Increased yostification, through employee involvement in CL &amp; PS (+) Increased vorkload, due to slower and more even work pace (-) Increased optication through employee involvement in CL &amp; PS (+) Increased optication through employee involvement in CL &amp; PS (+) Increased optication through employee involvement in CL &amp; PS (+) Increased optication, through employee involvement in CL &amp; PS (+) Increased optication,</li></ul>	<ul> <li>views, 82 questionnaires, 8</li> <li>comparies. Lear tools: value stream mapping, standardization, 55, improvement groups incoment groups incoment groups and stressful work (+)</li> <li>Conference paper, Qualitative case study of large company implementing Lean.</li> <li>Andersson &amp; Liljenvald</li> <li>Conference paper, Qualitative case study of large company implementing Lean.</li> <li>Andersson &amp; Liljenvald</li> <li>Conference paper, Qualitative case study of large company implementing lean.</li> <li>Reduced cycle times (-)</li> <li>Reduced cycle tim</li></ul>	& quantitative study (41 inter-		
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