



# The impact of lean production on musculoskeletal and psychosocial risks: An examination of sociotechnical trends over 20 years



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## ABSTRACT

This paper provides an extensive review of studies carried out in lean production environments in the last 20 years. It aims to identify the effects of lean production (negative or positive) on occupational health and related risk factors. Thirty-six studies of lean effects were accepted from the literature search and sorted by sector and type of outcome. Lean production was found to have a negative effect on health and risk factors; the most negative outcomes being found in the earliest studies in the automotive industry. However, examples of mixed and positive effects were also found in the literature. The strongest correlations of lean production with stress were found for characteristics found in Just-In-Time production that related to reduced cycle time and reduction of resources. Increased musculoskeletal risk symptoms were related to increases of work pace and lack of recovery time also found in Just-In-Time systems. An interaction model is developed to propose a pathway from lean production characteristics to musculoskeletal and psychosocial risk factors and also positive outcomes. An examination is also made of the changing focus of studies investigating the consequences of lean production over a 20-year period. Theories about the effects of lean production have evolved from a conceptualization that it is an inherently harmful management system, to a view that it can have mixed effects depending on the management style of the organization and the specific way it is implemented.

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## 1. Introduction

Sociotechnical systems theory (STS) as developed by the Tavistock Institute of Human Relations in the 1950s was strongly rooted in the mechanised production systems of the day; see, for example, the study of weaving mills in India (Rice, 1958). Sociotechnical system design in manufacturing was developed as an alternative to Tayloristic production systems and led to a design approach, particularly popular in Scandinavian countries (Weisbord, 1990), that did away with paced assembly lines in favour of production cells in which multi-skilled semi-autonomous work groups had considerable discretion over working practices. However, it is lean production methods that have been the dominant force in manufacturing around the world and these are now spreading to many sectors beyond manufacturing. “Lean production was born in Japan and developed to cope with a capital shortage caused by the devastation of World War Two”, (Price, 1995 in Babson ed.). It was founded on a belief that the key to improving profit was to reduce cost. Taiichi Ohno implemented the lean system in Toyota in the 1970s (Ohno, 1998).

Lean production was also introduced as a successor to Tayloristic production systems but is often criticised as neo-taylorism. Niepce and Molleman (1998), evaluated lean systems against the principles of SocioTechnical Systems theory. Some similarities were identified mainly regarding the introduction of work groups. The main differences concerned the value bases and assumptions about workers and the way control at work is exercised in the two approaches. A sustainable synthesis of these systems keeping the best of each system was investigated. Other researchers have proposed a sociotechnical framework for lean production implementation (Paez et al., 2004). However, the question remains; are there characteristics of lean production that mean it cannot lead to the good quality jobs that are central tenets in sociotechnical systems theory?

Although STS in manufacturing is associated with a particular kind of design solution the theory, as Eason (1988) has pointed out, can be used to investigate the effectiveness of any work system. The theory suggests that, because of their tight interdependencies, technical and social system sub-systems must be co-optimised to produce an effective work system. Eason (1996, 2007) has shown that on many occasions what happens is that a technical system is implemented that leads to unwanted, negative effects in the social system with implications for the performance of the whole system.

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The purpose of the literature review reported here, was to examine the consequences of lean production for the health and safety of workers, i.e. to examine the implications of this kind of technical system for some aspects of the social system. Lean production has been evolving and spreading over the past 20 years and there have been many studies of its impact on health and safety and this review will, in particular, examine emergent trends during this period.

There were many studies of lean production in the 1990s primarily in automotive manufacturing (e.g. Adler et al., 1997; Babson, 1993; Berggren et al., 1991; Lewchuck and Robertson, 1996). However, in the last decade new studies have focused on lean effects in other manufacturing sectors and in the service sector (e.g. Conti et al., 2006; Jackson and Mullarkey, 2000; Sprigg and Jackson, 2006). Some researchers have reconsidered the belief that lean is inherently 'mean' particularly in other than automotive industries where lean production is not fully implemented. Specific lean practices have been examined for their correlation with stress and musculoskeletal disorders. Therefore, there is an evidence base that can be used to understand the mechanisms underpinning the health effects of lean production. This review will investigate, whether specific characteristics of lean production lead to specific risk factors and health effects.

Internal work organisation and work patterns are constantly changing around the world in response to macro trends like globalisation and the resulting fierce market competition. In the last three decades new organisational systems have been introduced. Flexibility has been achieved through new production systems but improvements in productivity have not been sufficient for enterprises to be competitive. New strategies have been adopted that attach importance to quality and the satisfaction of clients. Lean production is perceived as a strategy that can achieve internal flexibility attuned to customer requests and the need to minimise waste. The European Commission Green Paper 'Partnership for a new organisation of work' (1997) stresses that the challenge is how to develop or adopt policies that support rather than hinder organisational renewal and to strike a productive balance between the interests of business and the interests of workers (Koukoulaki, 2010).

This paper reviews studies that were carried out the last 20 years and identifies the lean characteristics that lead to positive or negative effects on health and safety (psychosocial and musculoskeletal effects). Both effects are examined in this paper since there is potentially a correlation. Psychosocial exposure apart from stress and mental disorders can also lead to musculoskeletal disorders. Moreover lean production can create time pressure that affects all parameters of physical and mental workload. A comparison between lean effects in different manufacturing sectors and services is made. An interaction model of the effects of lean production on job characteristics and their relation to musculoskeletal and psychosocial risks is proposed.

## 2. Method of literature review

The purpose of the literature review was to identify the effects (positive or negative) of particular lean practices on people at work. The author looked in particular for effects on work characteristics, psychosocial factors and stress, ergonomic risk factors and musculoskeletal disorders. The review covered papers published between 1990 and 2013 and included a study of changes in the focus of investigations over this period. The search was conducted using the databases, Medline, Pubmed, Scopus, EBSCO, EMBASE, NIOSHtic2, HSELINE and Ergonomic Abstracts, as well as other scientific literature. The search combined three groups of terms; lean production indicators, indicators for work characteristics and indicators for risk factors and health effects (Table 1).

The inclusion criteria for the search were:

- Papers published in English from 1990
- Studies published in peer-reviewed scientific journals.
- Studies implementing lean production practices such as Just-in-Time, standardised process, waste reduction, continuous improvement, etc.
- Studies examining outcomes of lean production such as effects on job characteristics, risk factors and health effects (musculoskeletal and stress).
- Studies carried out in manufacturing sectors and services.
- Epidemiological studies and case studies were included.

The exclusion criteria were:

- Organisational practices not qualified as lean
- Outcomes not accepted as health indicators, job characteristics or risk factors. Papers investigating lean implementation and company productivity or similar performance effects were excluded.

About 700 papers were identified in the initial search. At the first level the papers were screened by their title and abstract and 570 were excluded. At the second level 130 papers were screened by reading full text. In total 36 studies were finally included in the review of which 16 were conducted in automotive industry, 10 in other manufacturing sectors and 10 in services and mixed sectors. Quality assessment of the papers was made by the author and was based on the type of the study and the size of the sample, the lean implementation period (adequate to demonstrate effects), the validity of the methods used to examine the effects and the strength of the findings. The literature survey process is illustrated in the flowchart in Fig. 1.

## 3. Lean production

Production optimisation systems include a number of related technologies, management systems and practices that all aim at increasing productivity and quality and at the same time reducing costs. Examples are lean production, Just-in-Time (JIT), Six Sigma, Total Quality Management (TQM), agile manufacturing and others. The application of one technique does not exclude the others.

**Table 1**  
Literature review search terms.

Lean production indicators	Work characteristics indicators	Indicators for risk factors and health effects
Lean	Job	Effect
Lean production	Demands	Health
Waste reduction	Control	Strain
Toyota system	Work	Fatigue
Just in Time	Overload	Risk
JIT	Work load	Psychosocial risk factors
Flexible	Workload	Psychosocial
Organizational change	Empowerment	Well being
Total quality management	Involvement	Stress
TQM	Team	Musculoskeletal disorders
	Autonomous teams	MSD
	Self-managed teams	Upper limb disorders
	Autonomy	Ergonomics
	Job satisfaction	Ergonomic
	Time pressure	Health and safety
	Work pace	Working conditions

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