Chapter 15

Lean Production and Its Impact on Worker Health:
Force and Fatigue-Based Evaluation Approaches

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ABSTRACT

Lean is currently applied successfully in many industrial sectors. However, its value and impact on human health is not fully understood. To gain a better understanding, this chapter explores how ergonomics force and fatigue evaluation methods can be applied in a manner to enhance lean initiatives. These methods incorporate ergonomic-related variables of force type, force duration, force frequency, and degree of awkward posture, and incorporate the recommended cumulative rest allowance (RCRA) model as a practical fatigue-based metric. These methods and their application are discussed.

INTRODUCTION

In today's global competition, successful companies focus on diversity and inclusion as a source of competitive advantage. The organizations use diverse methods and techniques to improve their productivity, quality, and profitability. In order to achieve this, the work organization system of lean production has been widely adopted throughout the industrial world. Lean originates from the Toyota Production System and has been recognized as doing more with less. Thus, it is oriented toward reduction of unnecessary variations and steps in the work process by the elimination of waste, which can be thought of as a non-value-added aspect of a product or service. Originally, the focus was paid to the elimination of wastes such as defects requiring rework, unnecessary processing steps, movement of materials or people,

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waiting time, excess inventory, and overproduction. But today Lean systems impact a wide-range of manufacturing related systems including the initial stages of product life cycle such as product development, procurement and manufacturing over to distribution (Womack & Jones, 1996). The most common practices associated with lean production are the following: bottleneck removal (production smoothing), cellular manufacturing, competitive benchmarking, continuous improvement programs, cross-functional work force, cycle time reductions, focused factory production, just-in-time/continuous flow production, lot size reductions, maintenance optimization, new process equipment/technologies, planning and scheduling strategies, preventive maintenance, process capability measurements, pull system/Kanban, quality management programs, quick changeover techniques, reengineered production process, safety improvement programs, self-directed work teams, and total quality management (Shah & Ward, 2003).

It should be clearly pointed out that the misusage of lean techniques can lead to overlooking issues that lead to health problems, injuries, or even accidents. All these consequences lead to the need to spend money on compensation claims, which may be the best example of waste (Pai et. 2009). The awareness of the relationship between worker health and lean among lean practitioners is not always visible. There are some studies which show such an impact in the areas of occupational injuries and illnesses, or job characteristics related to job strain and linked to hypertension and cardiovascular disease (Landsbergis et al., 1999). Furthermore, it has been investigated that lean production can empower workers (Shah & Ward, 2003; Taj & Morosan, 2011) as it requires intensified work pace and increased job demands. Decision authority and skill levels can increase modestly or temporarily, while decision latitude is kept at low level which can lead to job strain and finally, musculoskeletal disorders. In jobs with ergonomic stressors, intensification of labor appears to lead to increases in musculoskeletal disorders (Landsbergis et al., 1999). Lean may result in raised stress levels and therefore increase worker turnover and absenteeism with a negative impact on manufacturing performance (Gill, 2003). However, further studies revealed that this approach in fact increases the stress levels. But not on the shop floor as it was previously suggested, but rather on the managerial level (Sangwan, 2013). Furthermore, when lean was tested against such work organization models as: Taylorism model, human relations model and socio-technology models, on the two dimensions central or decentralized orientation and human factor orientation; it turned out that it outperforms both the Taylorism model and the human relations model (European Foundation Report, 2001).

Ergonomics is defined as the application of theory, principles, data and methods to design a system which accommodates both the human operator's capabilities and limitations in the work process (Wickens, 1992). Ergonomics enables us to better understand the interactions among humans and other elements of a system, allowing the optimization of overall system performance (Naranjo-Flores et. al, 2014). Ergonomics continues to become more and more important in industry due to the positive influence on productivity and efficiency as well as its modern-day focus to reduce or prevent work-related injuries. It should be appreciated that ergonomics and lean are highly inter-related. Ergonomic risks are strongly associated with lean-related wastes; and lean transformation should naturally lead to ergonomic risk reduction (Aqlan et. al, 2013). Despite these facts, many companies have implemented lean-related systems to control productivity and quality, without a clear understanding of the potential of ergonomics to contribute to the objectives of lean.

The purpose of this research is to better understand and communicate the application of modern ergonomics force and fatigue evaluation methods in lean initiatives. To achieve this objective, a systematic search of the literature was be carried out using the following electronic databases: MEDLINE, PubMed, Scopus, Clarivate Analytics (former Web of Science) and Science Direct. All databases were searched