PRODUCTION OPTIMISATION SYSTEMS AND CONSEQUENCES FOR WORKERS' HEALTH & SAFETY:
LEAN PRODUCTION AND EFFECTS ON STRESS AND MUSCULOSKELETAL DISORDERS

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by

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To Nick, my husband, that has offered me tremendous support with his positive energy and continuous encouragement throughout this hard work.

I want to dedicate this doctoral thesis to my first cousin Theoni Spyropoulou that left us unexpectedly so young and full of dreams and didn't have the opportunity to complete her PhD.

Are we confronted with a tragic, insolvable dilemma? Must we produce sick people in order to have a healthy economy, or can we use our material resources, our inventions, our computers to serve the ends of man?

Must individuals be passive and dependent in order to have strong and well-functioning organizations?

Erich Fromm

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1. ABSTRACT

This thesis investigates production optimisation systems such as lean production and their consequences for the health and safety of workers. In particular it examines potential positive effects and adverse effects on stress and musculoskeletal disorders (MSDs). The thesis comprises an extended literature survey and a field study in the manufacturing and the services sector applying lean production.

It provides an extensive review of studies carried out in lean production environments in the last 20 years that 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.

The field study was carried out in lean environments in the manufacturing and services sectors, namely in the electronics, beverage, and metal industry and call centres in Greece and UK. For the psychosocial factors and recording of MSD symptoms; self reported questionnaires were administrated to the workers. In total 353 workers responded to the questionnaires. Additionally qualitative data were collected through semi-structured interviews with managers and lean officials, safety officers and workers in the sample. Finally, observation

visits in the companies completed the data collection process. The lean implementation level of the companies was estimated on a five-point scale, according to a validated model (Conti et al, 2006). A follow up study to collect qualitative data was possible in one company in the sample.

The research hypotheses of the field study tested the relationship between job stress and MSDs with quantitative job demands, job control, performance monitoring, and the level of lean implementation. The hypotheses were partly supported in both sectors:

- In the service sector findings confirm that quantitative job demands are predictors of job stress, consistent with similar studies in call centres. Stress is strongly associated with MSD development.
- In the manufacturing sector, quantitative job demands were not predictors of job stress, neither of MSDs. Positive challenges were a mediator of job stress. Stress was not a predictor for MSDs symptoms. Mechanical exposure increased after lean implementation in manufacturing although the opposite was aimed at. Consultation of workers on lean characteristics was another mediator to MSD development.

A comparison was made between manufacturing and the services sectors. Differences between sectors in job demands -with the exception of learning demands that are higher in manufacturing- were not significant. Predictability on the other hand was higher in call centres. Employees in the call centres reported statistically significant more frequent MSD symptoms compared to workers in manufacturing. Stress differences were not significant among sectors whereas job satisfaction was significantly higher in manufacturing. This can partly be explained by the positive social context, job security and management commitment to have no lay offs due to lean application; that workers enjoyed in the manufacturing companies of the sample. This was not the case in the call centres.

In conclusion it was not the stressors that were higher in the call centres' sample but a significant number of job support and control characteristics that were reported as being higher in the manufacturing sample of the study.

Analysis of the relationship between job characteristics, stress and leanness revealed a high degree of non-linearity. The best fit was achieved with quadratic curves. At low levels of lean implementation stress was increasing. At a middle level of implementation stress reached a peak after which, with advanced implementation, it decreased. This is consistent with earlier study findings.

The study demonstrates that it is not so much the level of lean implementation that is important for the health & safety effects but the lean characteristics that are employed. Characteristics linked to JIT can be critical and can be associated with increased job demands and for some cases increased stress and MSD symptoms. Moreover it is the social context (management mentality and actual workers participation) in lean application that is crucial for the implications of lean work to health.

Further research is needed to compare lean effects between sectors including also other services. Finally, more research is needed on alternatives to intensive systems that would have better consequences for the health & safety of workers. Ergonomics has an obligation to propose work redesign that aims at sustainability for all parties.

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LIST OF DIAGRAMS

GLOSSARY

Added value: Any operation in lean production which enriches the product for the customer. One added value operation is the activity for which the customer is willing to pay.

Cellular manufacturing: The production is usally arranged in U form cells. It is a single piece manufacturing process from beginning to the end of the production cycle without intermediate stock. It improves flexibility and allows rotation of workers among work posts.

Five S, (5S): The 5S system comprises sort, set in order, shine (and inspect), standardize and sustain.

Fordism: The work organization model characteristic of the 20th centrury mass production. It is based on the Taylorism principles.

JDC: Job Demand Control Stress Model

JDCS: Job Demand Control, Support Stress Model

Jidoka: A principle that aims at production process stabilisation and quality assurance targeting zero defects. It prevents defects by preventing human errors. Poka yoke is the tool to achieve this principle.

JIT: Just in Time, a production strategy that produces and delivers only the necessary quantity to the client and only when it is requested.

Job Stress: People experience stress when they perceive that there is an imbalance between the demands made of them and the resources they have available to cope with those demands (EU-OSHA).

HPWS: High Performance Work Systems, aims at continuous effectiveness improvement.

Kaizen: Philosophy of continuous improvement for waste reduction, operation simplification and client satisfaction.

Kanban: It is a visual tool to achieve JIT. It is actually information (in form of cards or electronic board) on the client request and the relevant production data which authorizes only the necessary production.

Lean production: It is a concept comprising Just In Time practices, recource reduction, improvement strategies, defects control and standardization (Pettersen, 2009).

MSD: Musculoskeletal Disorders, Work related Musculoskeletal Disorders (MSD) cover a wide range of inflammatory and degenerative diseases of the locomotor system (Buckle and David, 2000).

OSH: Occupational Safety and Health

Poka - yoke: Mistake proof, an anti-error system that guarantees the product conformity to the standardization process and the quality standards.

Polyvalence: The aptitude of the operator to work in different posts. This permits rotation of operators and allows flexibility in the organisation.

Psychosocial factors/risks: Work related psychosocial risks concern aspects of the design and management of work and its social and organisational contexts that have the potential for causing psychological or physical harm (Leka et al., 2003). Psychosocial risks are job demands, time pressure, low job control, social relations with superiors and colleagues, job insecurity, etc.

SMED: Single Minute Exchange of Die, is a demand for rapid changeover of dies and startup of machines in the production process. SMED is another method for reducing waste and achieve continuous production flow.

Standardisation: It normalizes all operations in production and corresponds to the optimal way of work applied by all workers.

Takt time: The Takt time is the pace of production needed to meet customer demand. Takt time differs from cycle time, which is the actual time it takes to do the process.

Taylorism: Scientific organization model that characterizes mass production.

Toyotism: The approach of the TPS

TPM: Total Preventive Maintenance is periodic machine maintenance aiming at zero breakdowns. It is the key to production stability and permits flexibility.

TPS: Toyota Production System

TQM: Total Quality Management

Visual Management: The principle of this system is to visualize the out-of standard situation and make it obvious at a glance. Visual management uses 5S to achieve that.

VSM (Value Stream Mapping): It's a map of value flux in a lean company in order to identify and reduce waste.

Waste/Muda: Lean production considers waste any operation or activity that does not add value to the product. It has to be minimized to make the process more effective. Examples of waste are overprocessing, inventory, operproduction, delays and unnecessary motion

PUBLICATIONS

1) Koukoulaki, T., 2010, New trends in work environment - New effects on safety, Safety Science, Vol 48, Issue 8, pp. 936-942.

Cited in:

1) Santos, G., Barros, S., Mendes, F., Lopes, N., The main benefits associated with health and safety management systems certification in Portuguese small and medium enterprises post quality management system certification, Safety Science. 01/2013; 51(1):29–36.

2) Gressgårda, L. J., Dynamics between safety, trust and management during organizational change

2) Koukoulaki, T., 2014, The impact of lean production on musculoskeletal and psychosocial risks: An examination of sociotechnical trends over 20 years, Applied Ergonomics, Vol 45, Issue 2, pp. 198-212.

The publications are put in the Appendices 10.1. and 10.2.

2. FOREWORD

The automotive industry is dominated by lean manufacturing and similar production optimisation systems. Lean production has expanded to other manufacturing sectors, construction and the services, namely health care, call centres and the public sector. In a globalised business environment that is increasingly demanding, these systems are intended to enable companies to obtain maximum effectiveness and flexibility. However important questions about the implications of these systems on working conditions have been raised by researchers. For lean production to be considered viable it must, according to some researchers, minimise its potential negative effects on the workers who are at the heart of making the system work (Johansson & Abrahamsson, 2009, Hasle et al, 2012).

This study investigates the consequences of lean production for workers health & safety focusing on effects on psychosocial factors and musculoskeletal disorders.

The contribution to original knowledge of this thesis is that it provides a trend analysis in time and suggests a pathway from lean characteristics to positive effects and effects to stress and MSDs. Moreover the pathway is tested in a field study where a comparison is made between the effects of lean practices' application in services and manufacturing sectors. Two peer reviewed publications were produced by this thesis. The contribution of this thesis to practice is that it recognises buffers in lean effects in manufacturing and services that are emerging lean systems.

3. INTRODUCTION – BACKGROUND

3.1. INTRODUCTION

This chapter's purpose is to examine lean production and its component parts, alternative production systems and to review the different kinds of stresses on workers that have been associated with it.

3.2. LEAN PRODUCTION

In the spring of 1950s, Toyota engineer Taiichi Ohno created the foundation for lean production, an improved alternative to mass production. The latter would not work in Japan, where the economy had been torn apart by the war and investments were impossible (Dennis, 2002).

In the 1970s economic, social and political changes influenced the world markets and mass production. Mass production with high inventories was based on the availability of cheap raw materials and sources of energy. Dramatic increases in raw materials and oil prices in the 1970s subsequently increased the production cost and brought tremendous difficulties to this system that led to the collapse of the mass production industry (Piore and Sable, 1984). In the last decades new organizational systems have been introduced as a panacea to the mass production crisis all over the world. 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. Gradually it became clear that organisations were facing new functional demands: besides efficiency, markets demanded quality, flexibility, and innovativeness (Bolwijn and Kumpe, 1990). Continuous production optimisation and customer satisfaction have become major targets.

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.

There is no consensus on a definition of lean production between authors in the literature (Pettersen, 2009) but one central and agreed purpose of lean production is waste reduction. For that reason work processes are designed to eliminate waste (muda) through the process of continuous improvement (kaizen). Waste is defined as ‘non-value adding’ activities. Examples of ‘muda’ are overproduction, waiting, excess inventory, motion, defects, etc. To avoid overproduction, a ‘pull’ system is used where only the required material is produced (Just-in-Time approach). The pull system uses visual signals (Kanban) to indicate the demand and schedule production. Since no or little inventory is allowed in lean production, and in order to achieve Just in Time, lean companies form partnerships with suppliers to deliver on–time high quality parts. Just in Time is based on machinery (mixed model production) and people flexibility (multiskilled problem solvers who rotate from job to job, Dennis, 2002).

5S and Total Preventive Maintenance (TPM) are keys to machine stability and effectiveness. 5S is a system of workplace organization for a clean and ordered environment (housekeeping) comprising techniques for Sorting, Setting in order, Shining and inspecting, Standardising and Sustaining. TPM target is zero breakdowns (Nakajima, 1988).

Another practice to reduce inventory and maintain continuous production flow is ‘set up reduction’, that is reduction of the time to change from manufacturing one item to another. Single Minute Exchange of Die (SMED) is another method for reducing waste that aims at a rapid changeover of dies and startup of machines.

Ensuring quality and continuous problem solving are priority issues in lean production, (Liker, 2004). TQM is a management strategy that aims at increasing quality in all organisational processes. TQM is a tool that is being used in lean production to achieve its objectives. Mistake proofing or failure prevention (poka yoke) is another central characteristic of lean production (Pattersen, 2009). Poka yokes are techniques that aim at preventing product defects by helping employees to avoid mistakes or common errors.

Standardised work is also critical in lean production. Standardised work comprises three elements: takt time, work sequence (what is the best way to do the process?) and in process stock (max inventory). Takt time is the pace of production needed to meet customer demand. Takt time differs from cycle time, which is the actual time it takes to do the process. The goal of lean production is to synchronise takt time with cycle time (Pascal, 2002). Summarising the lean characteristics, lean is a concept comprising Just-in-Time practices, waste reduction, improvement strategies, defect control and standardization.

In table 1 that follows basic lean characteristics were reviewed in the literature. As a result of this review the following characteristics have been used based on Conti et al. (2006, p. 1016, exact table).

Table 1: Lean production elements, definitions and references

Lean production element	Definition	References
Set up reduction	Reducing the time to change from making one item to making a different item. Shortens lead times and reduces inventory	Shingo (1981, p. 63), Schonberger (1982, p. 20), Krajewski and Ritzman (2003, pp. 439, 451) and Suzaki (1987, pp. 33, 167)
Inventory and waste reduction	Waste is any activity that does not add value for the customer. Excess inventory is a major waste and a prime reduction target	Shingo (1981, p. 112), Schonberger (1982, p. 18), Krajewski and Ritzman (2003, 439) and Suzaki (1987, p. 7)
Kanban Pull signals	A shopfloor control system of visual signals from using to supplying work centres indicating the need for more parts. This ”pulls” the needed replacement parts based on actual usage, or demand	Shingo (1981, p. 272), Schonberger (1982, p. 85), Krajewski and Ritzman (2003, pp. 437, 444) and Suzaki (1987, p. 146)
Supplier partnerships	Lean firms form cooperative supplier relationships, sharing design and cost improvement responsibilities and emphasising the on-time delivery of high quality parts	Shingo (1981, p. 219), Schonberger (1982, p. 157), Krajewski and Ritzman (2003, p. 441) and Suzaki (1987, p. 196)
Continuous Improvement Program	An on-going program of improving the quality, costs and lead times of processes and products, through the cooperative efforts of shop workers and engineers. Often referred to as ”kaizen”	Shingo (1981, p. 7), Schonberger (1982, p. 181), Krajewski and Ritzman (2003, p. 443) and Suzaki (1987, p. 69)
Mixed-Model production /(Continuous flow – Cellular production)	Assembling different products and product variations on the same line. Balances shopfloor workloads when combined with level production schedules. Reduces lead times and	Shingo (1981, pp. 191, 204), Schonberger (1982, 93), Krajewski and Ritzman (2003, 440) and Suzaki (1987, p. 124)

	inventories	
Total Quality Management	Integrated program for improving process and product quality through techniques such as statistical process control (SPC), ”quality at the source” (workers self-inspect and stop the line if defects occur) and supplier pre-delivery quality control	Shingo (1981, p. 34), Schonberger (1982, p. 49), Krajewski and Ritzman (2003, pp. 114, 438) and Suzaki (1987, p. 101)
Mistake proof (poka-yoke)	Foolproof techniques seek to eliminate judgement and discretion in performing production tasks to produce high-reliability products. DFA is a computer rule-based design system for reducing the parts in a product, improving quality and reducing costs	Shingo (1981, p. 25), Schonberger (1998, p. 3) and Suzaki (1987, p. 135)
Total Preventive Maintenance	Highly organised program of periodic machine maintenance, and pre-emptive replacement of components such as bearings to minimise the frequency and duration of machine break-downs. Routine minor maintenance during work hours is done by workers	Shingo (1981, p. 188), Schonberger (1982, p. 136), Krajewski and Ritzman (2003, p. 442) and Suzaki (1987, p. 113)
Standard Operating Procedures (SOP)	Detailed descriptions of production tasks are documented to aid in organisational learning, training and ISO 9000 compliance. Helps maintain the cumulative effect of continuous improvement	Shingo (1981, p. 219), Krajewski and Ritzman (2003, p. 441) and Suzaki (1987, p. 135)

Source: Fullerton et al. (2003)

Lean production first appeared in the automotive industry, was later disseminated to other manufacturing areas and recently to services, namely healthcare, telecommunications, public services and others.

Oeij &Wiezer, (2002) found it difficult to make clear distinctions between organisational concepts (like Taylorism, lean production and sociotechnology) and business practices that are used within such concepts as TQM and Just-in-Time systems. Hybrid forms (intermediate forms) are usually applied in other than automotive manufacturing and services and this further complicate the distinction between lean production practices and organisational forms. This problem of distinction affects the evaluation of possible effects that work organisation and particularly lean practices have on working conditions.

3.3. Alternative systems to lean production

This section will introduce alternative systems to lean production. To design the future, past alternatives and the reasons for their successes or failures must be understood.

Lean production appeared as a successor of traditional mass production systems. In the past other models alternative to lean production were experimented with before its predominance. According to Sandberg (2007), the prevalence of lean is due to «globalization that put pressure on homogenization of production processes» (Sanberg, 2007, preface). Lewis (2000) reported that Toyota was merely seeking to survive the oil price shock of 1972- 1973 before lean production was universally accepted.

The paradigm of Volvo's Uddevalla car plant, offering a new concept for production and professional learning is an example of an alternative approach. The so-called 'natural work' holistic approach applied in the plant combined genuine control by workers, democratic election processes, and innovative learning strategies for acquiring their competences (Nillson, in Sanberg, 2007). The human-centred production process was conceived in collaboration with the unions and external consultants as specialists. Although the project was innovative and quite promising, the plant lasted only 7 years (from 1986 to 1993). In this section this production system will not be described in detail, since this is outside of the scope of the thesis. The focus is on understanding the reasons why this system failed to survive. The argument behind the closure of the Uddevalla plant was that it had equal efficiency but higher production costs in comparison to other Volvo plants. This argument was questioned as being based on false assumptions, by the researchers/consultants in the Uddevalla plant development (Nillson in Sanberg, 2007). In their opinion the underlying cause of failure was that the philosophy of decision makers, from the very beginning of the project, was additive to existing production systems and not the holistic change that the model was supposed to be. The strategies created for this plant, especially the extensive learning strategies for the employees, were not applied throughout the phases of its development (only at the beginning). Therefore the full potential of this model could not be demonstrated. The "Uddevalla experiment" was finally listed as not viable compared to lean production. However, one should reflect also on the financial and social environment, in Sweden and internationally, at the time of the decision to close the Uddevalla' plant. Unemployment was rising and the trade unions who had earlier fiercely demanded good quality of work in Sweden were cornered. Also the international competitive environment in the car industry had changed, with new companies entering the niche market. Womack's (1990) book, which contained analytical performance statistics for different management systems, praised lean production as the only effective system, although it gave second priority to human aspects. This book was a smash hit in the period when the closure of the Uddevalla plant was being considered. Finally and most crucially, Volvo's sales were dropping. This fact, independently of its significance that cannot be ignored, has worked as a pretext for the management to stop the experimental democratic prototype it had allowed. Volvo reacted to all these challenges with the premature -according to the consultants of the concept and other researchers (Nillson, 2007, Rehder, 1994) - closure of the Uddevalla plant and the selection of the old Torlanda plant as the main plant in which to apply lean production.

While Uddevalla, still operated, General Motors (GM) in Tennessee (US) had developed a similar car industry prototype in collaboration with the automotive unions, applying also benchmarking techniques to apply best production practices (including also Uddevalla plant in the visits). Saturn was a hybrid of Japanese lean production with humanised characteristics although more intensive compared to Uddevalla. The bitter end of this story is that GM stopped any new Saturn production in 2009 and ended the Saturn brand in 2010.

Rehder (1994) carried out an interesting and thorough analysis of both "humanised" (quoting from Rehder) plants and the NUMMI plant[1] (application of pure lean production) following his respective study visits. He described Uddevalla as a "soundless", clean factory with innovative ergonomic technical solutions, impressive group dynamics and democratic procedures that were actually applied. There was no assembly line in the plant and every tool and machine was placed so that the operator was at the centre. Everyone was proud of their work. To conclude, it was close to a working paradise for workers and an ergonomists' dream come true, not only for the automotive sector. However, Rehder characterised the most innovative part of Uddevalla concept, the investment in intensive learning and competence acquisition procedures with incentives for the workers, as being one of its weaknesses. Highly competent workers with technical skills and knowledge to build a car with over 2,500 parts on their own, were too valuable to lose or to afford to have sick. Saturn, on the other hand, an American prototype compared to the Scandinavian one was aiming at combining high productivity and

[1] It will be described later in the literature review.

democratic working conditions. They adopted concepts from Uddevalla and technical innovations from different production systems (Opel factory in Germany). However in Saturn they aimed at a much shorter cycle time (7 minutes), much closer to the one in lean production (1 minute at that time). The Saturn factory, although it experienced many strikes throughout its operation, and was accused of being a Toyota stressful clone, did outlive Uddevalla. Rehder was also quite critical on the NUMMI plant, as described in the section of this thesis "Studies appraising lean production".

Adler & Cole at the same time (1993) also compared the Uddevalla and NUMMI plants (lean vs human centered) in terms of productivity and workers' morale and emphatically concluded that the lean plant was superior. The main argument in favour of NUMMI was the productivity (less assembly hours per car compared to the Swedish long work cycles). The same researchers claim that Uddevalla could have been ahead of its time (Adler & Cole, 1993).

What this critical glimpse of history tells us, is that one of the most successful features of these "democratic" production systems (Uddevalla & Saturn) was their participatory approach during development but more importantly during their application process. This is a more valid conclusion for the Uddevalla plant because it reached the optimum situation in this respect.

It is possible to conclude that it was not the Uddevalla concept that failed but its actual application**.** The Swedish management was intimidated by the notion that the competition was following another more effective and productive paradigm, the lean one. Moreover management failed to overcome its initial reservations about this experiment.

Researchers in recent times have tried to bring back the debate about balance between performance and good working conditions, (Johansson & Abrahamsson, 2009, Oeij &Wiezer, 2002, Docherty et al, 2002). Johansson & Abrahamsson review the old "good work" concept, developed in Sweden in the 1980s-early 1990s, in the shadow of lean production and specify the "new good work" approach. Quoting from Johansson & Abrahamsson, (2009, page 779), they say: «The development towards lean is neither possible nor desirable to stop». However, the paper ends up concluding that it is wishful thinking to expect the adoption of the good work concept in the framework of a lean environment that is not learning –friendly. Albeit the role of trade unions is recognised, their weakened position in a globalised and flexible labour market is acknowledged.

Modern High Performance Work System (HPWS) was offered as another alternative to Tayloristic systems and an evolution of lean production. However, some researchers of the high performance paradigm imply that it is mostly lean production (Godard, 2004). HPWS applies a combination of lean practices and human resources practices which strengthen employee involvement and encourage the acquisition and deployment of skills. A study of high performance work practices in the world automobile industry in the mid-1990s concluded that higher levels of organisational performance came from a combination of high performance work practices with lean production techniques (MacDuffie, 1995). Advocates of High Performance Work Systems claim that opportunities to acquire skills and workers' involvement are higher compared to lean production (Kalmi & Kauhanen 2008, Mohr & Zoghi, 2008). On the contrary, Ramsay et al. (2000) related job intensification to HPWS and job stress. Quite recently a comparison study of HPWS in the aerospace industry and lean production in the automotive industry revealed that companies, despite differences between their labour processes, have similar issues of degradation of work (Stewart, Richardson and Pulignano, 2010).

3.4 MUSCULOSKELETAL AND PSYCHOSOCIAL RISKS

This study examines the possible effects of lean practices on musculoskeletal disorders, stress and associated risk factors. Work related Musculoskeletal Disorders (MSD) cover a wide range of inflammatory and degenerative diseases of the locomotor system (Buckle and David, 2000). Musculoskeletal disorders have a multifactorial aetiology. Different groups of risk factors include physical and mechanical factors, organisational and psychosocial factors. Individual and personal factors may contribute to the genesis of MSDs. Examples of risk factors are repetitive handling at high frequency, awkward and static postures, force exertion, vibration, etc.

Although automation systems have been introduced and reduction of strenuous work has been achieved with the help of ergonomic interventions in the last decades, there is an increasing trend towards more physical risks and related musculoskeletal disorders. Musculoskeletal disorders are among the six most commonly recognized occupational diseases in Europe. The most frequent occupational disease is hand or wrist tenosynovitis followed by epicondylitis of the elbow and carpal tunnel syndrome comes sixth, (Eurostat, 2004).

Work related psychosocial risks concern aspects of the design and management of work and its social and organisational contexts that have the potential for causing psychological or physical harm (Leka et al., 2003). Psychosocial risks are job demands, time pressure, low job control, social relations with superiors and colleagues, job insecurity, etc. These risks are linked to work-related stress, violence and bullying. Stress is related to sleep disorders, cardiovascular diseases, depression and other disorders. A study in Germany found that high job demands (expert rated) were associated with major depression (Rau et al., 2010). A meta-analysis of 79 studies reporting cross-sectional and longitudinal relationships between physical symptoms and various occupational stressors found significant relationships between job stressors and gastrointestinal problems and sleep disturbances (Nixon et al., 2011). However, researchers have reported the effects of buffers in high demand environments. Dalgard et al. (2009) tested the Demand Control model and reported a strong ‘buffering effect’ for the interaction between demands and control. There was almost no increase in psychological distress when high job demands were combined with high control.

The HSE estimated in 1996 that in the UK stress-related illness is responsible for the loss of 6.5 million working days each year, costing employers around GB£370 million and society as a whole as much as GB£3.75 billion, (HSE, 1999). In 2004/2005, an estimated half a million people in Great Britain believed they were suffering from stress, depression or anxiety that was caused or made worse by their current or past work. An estimated 12.8 million working days were subsequently lost (Jones et al, 2003). In less than 10 years the estimated number of days lost due to stress has more than doubled in UK.

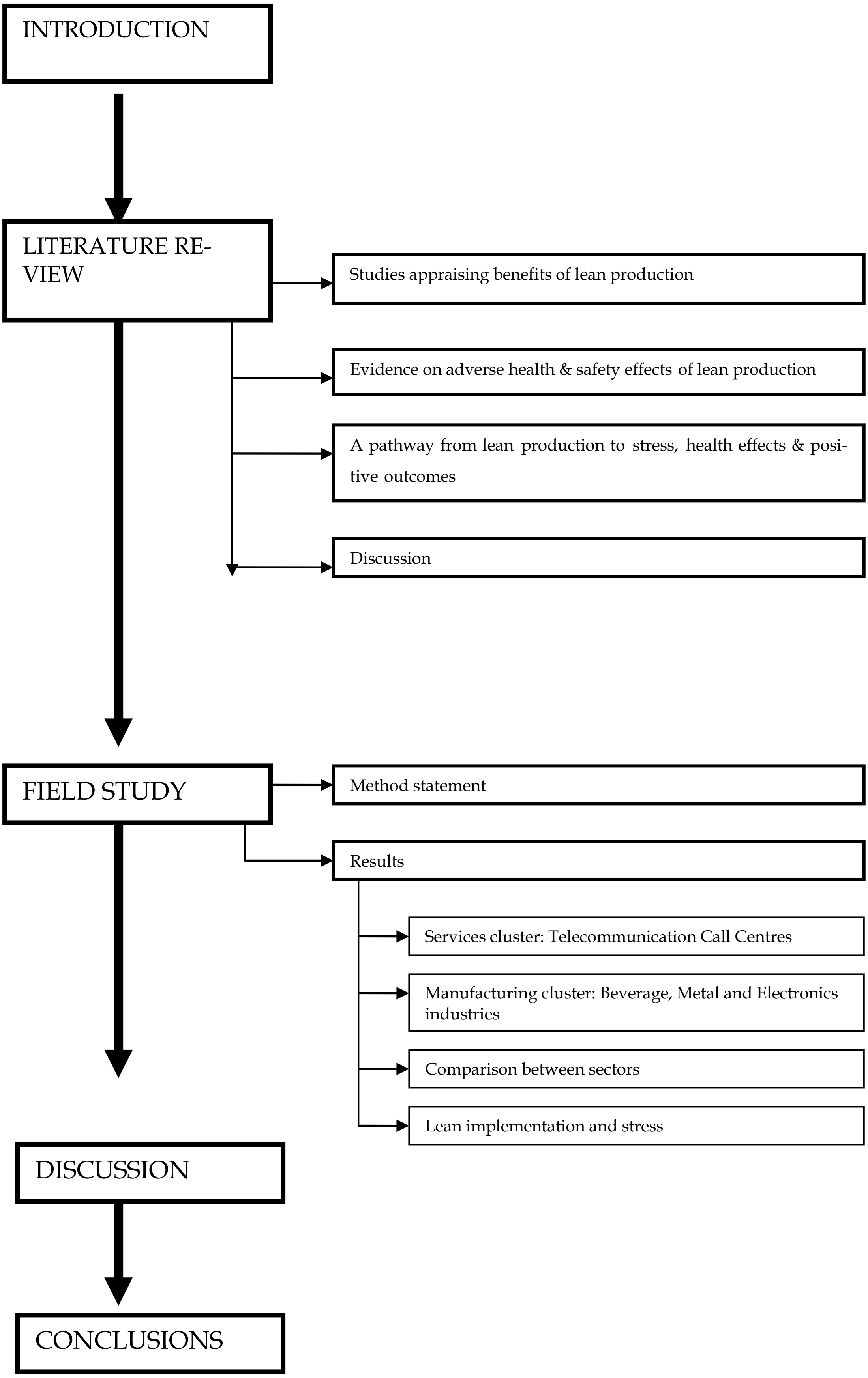
The European Commission in its strategy on health and safety at work 2007-2012 acknowledges the emerging problems of musculoskeletal complaints and psychosocial risks – it calls them new risks - that require a new focus and even legislative action. The Community Strategy also emphasises the importance of research into new and emerging risks for designing preventive solutions, (Koukoulaki, 2010).

To be able to plan successful preventive interventions for musculoskeletal and psychosocial risks and ensure sustainable work organisations, in a 'rationalisation era', the mechanisms by which new production systems have an impact on health need to be fully understood.

The present study aims at shedding some light on the consequences of production optimisation systems such as lean production in relation to the psychosocial environment and musculoskeletal disorders.

The thesis is organised in 5 main chapters, introduction, literature review, field study, discussion and conclusions. In appendices are a field study overview, the publications produced by this thesis, the questionnaires employed in the field study, and the statistical analysis tables. The structure of the thesis is illustrated in figure 1.

Figure 1: Structure of the thesis



4. LITERATURE REVIEW

4.1 METHOD OF LITERATURE REVIEW

The purpose of the literature review is to identify the effects (positive or negative) of particular lean practices on people at work. The aim was to look 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 2).

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 figure 2. (**Figure 2: Literature review process)**

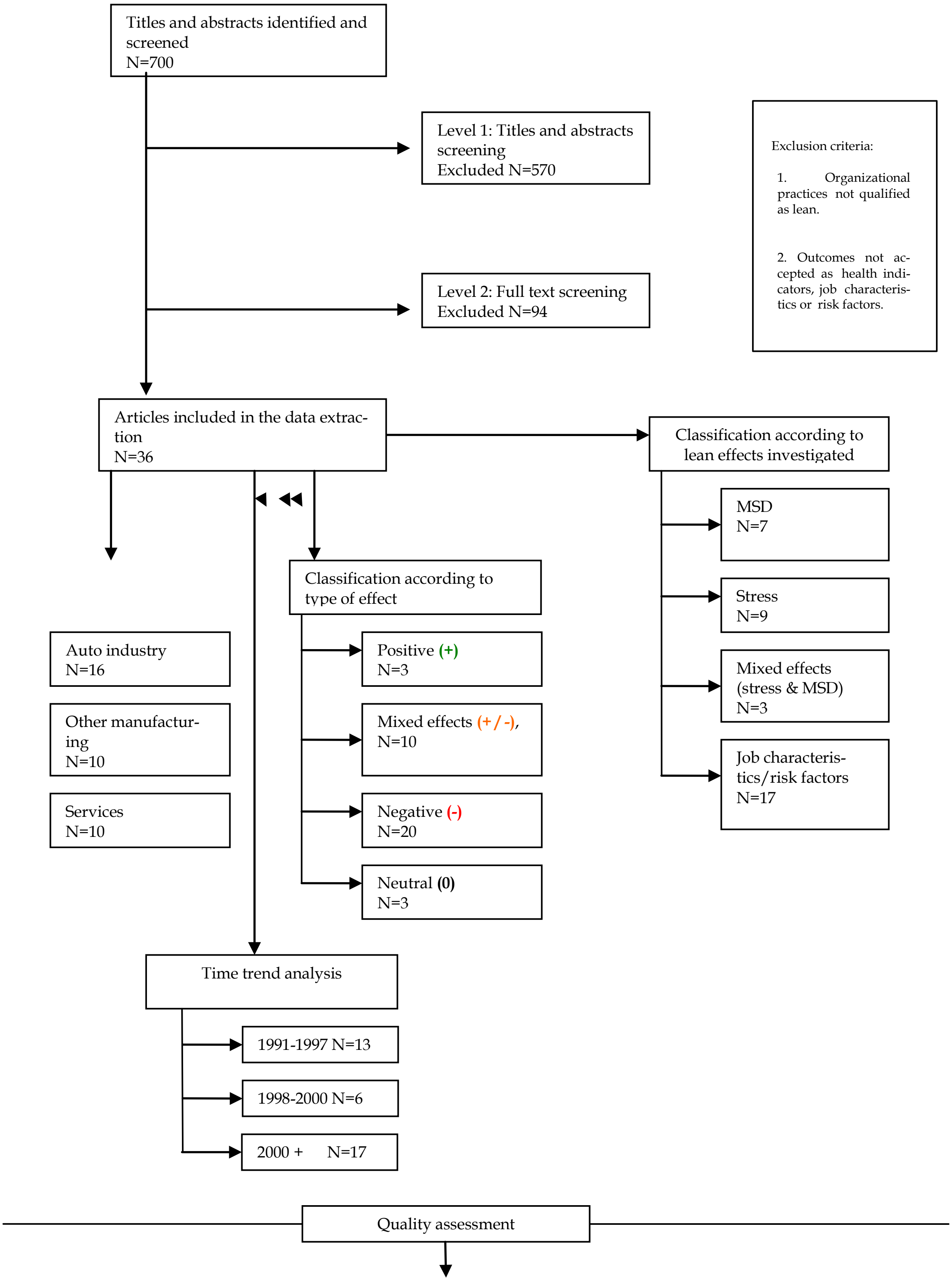


Table 2: Literature review search terms

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
new systems of work organization	involvement	Stress
modular manufacturing	team	musculoskeletal disorders
cellular manufacturing	autonomous teams	MSD
total quality management	self-managed teams	upper limb disorders
TQM	autonomy	ergonomics
	job satisfaction	Ergonomic
	time pressure	health and safety
	work pace	working conditions

4.2. RESULTS

4.2.1. STUDIES APPRAISING THE 'BENEFITS' OF LEAN PRODUCTION

Womack et al. (1990) in what many regard as enormously influencial book 'The machine that changed the world' argued that lean production is not only the most efficient system for manufacturing cars but is the one best way of organising all kinds of industrial production, featuring both dramatic increases in productivity and qualitative improvements in working conditions. The alleged benefits of lean production are job autonomy, worker participation, empowerment, job enlargement, etc. However researchers have questioned the promises of lean production.

Klein (1989) warned against over-promising the degree of autonomy when introducing lean production. Murakami (1994) observed that while with teamwork more 'autonomy' is given to the shopfloor, this 'autonomy' remains closely monitored and controlled by the company itself. There seems to be a general agreement that a typical lean plant provides low levels of job control and empowerment (see Appelbaum & Batt, 1994, Babson, 1993, Bruno & Jordan, 2002, Conti & Wagner, 1993, Jones et al., 2013, Lewchuck et al., 2001, Niepce & Molleman, 1998, Parker & Sprigg, 1998, Parker, 2003, Turnball, 1988). A few studies found mixed effects (both negative and positive) on workers' autonomy (Jackson & Mullarkey, 2000). In Jackson & Mullarkey's study autonomy variables were tested in two teams; a lean and a traditional one in the same company. Timing control was lower in the lean team compared to the traditional one where breadth of role of workers was higher.

Lewchuck et al., (2001) in a comparative study between lean automobile industries in Canada and UK concluded that lean production is not associated with increased empowerment or greater employee control over work. The findings varied more between companies than across countries. The variations were accounted for by different lean implementation strategies and poor relations with the unions. The study examined specific indicators of empowerment and job control that give added value to the conclusions. It also provided evidence that the context within which lean production is applied is important (industrial relations, productivity goals etc). Hampson (1999) observed that the surrounding social factors (e.g. union power and the means they have to implement their will) determine whether 'lean becomes mean' when it is implemented in an organisation. Bruno & Jordan, (2002) studied a cohort at Mitsubishi Motors where lean production was fully implemented for 8 years. Workers seemed frustrated with the rhetoric of empowerment in an environment offering no real power. Furthermore workers felt that management had used the production system against them. Quality Circles were not functioning, as the work was dictated by the management and the workers felt their ideas were rejected or stolen by the management. Bruno and Jordan's study used a large cohort of workers after a significant period of lean implementation time. Nevertheless the situation described seems to have been an extreme and 'hard' lean implementation. Conti & Wagner (1993) describe Quality Circles 'as a system according to which employees spend four hours a month on making their work for the rest of the month even more Taylor-like'. Appelbaum & Batt, (1994) and Babson, (1993) also recognise the limited opportunity Quality Circles have to influence managerial decisions. Fucini and Fucini (1990) reported that only suggestions by workers that are aimed at reducing costs, raising productivity or reducing time to perform tasks had a chance of being implemented by management. Parker (2003) made a before and after comparison of the introduction of lean practices in an assembly plant and also used an internal reference group of technicians who were not exposed to the lean production processes during the study period. The study concluded that lean production reduced job autonomy, employee participation and skill utilization. Parker supports the arguments of other researchers (e.g. Delbridge et al., 1992) that the multiple tasks in lean production teams actually represent multitasking instead of multiskilling. Parker also concluded that participation in decision-making in these teams was restricted. Niepce & Molleman, (1998), in a theoretical approach of lean production application, explain that autonomy is difficult to achieve because the standardisation of work processes leaves little room for job control. Moreover teams are built around the supervisor and cannot be autonomous. They argue that "participation of workers in lean production exists but is limited to certain areas of decision-making (e.g. quality, work procedures) and certain mechanisms for involvement (e.g. quality circles, improvement teams)". These authors conclude that the success of workers' participation in a work system depends on how it is introduced and applied. In lean production workers are expected, for example, to submit ideas for improvement in a standardised way (e.g. a certain number of ideas per period). Salvendy (1997) concurs concluding that "Enforced participation and quality circles, where ongoing suggestions for improvement are compulsory and part of the workers' job description, have been viewed with suspicion by trade unions".

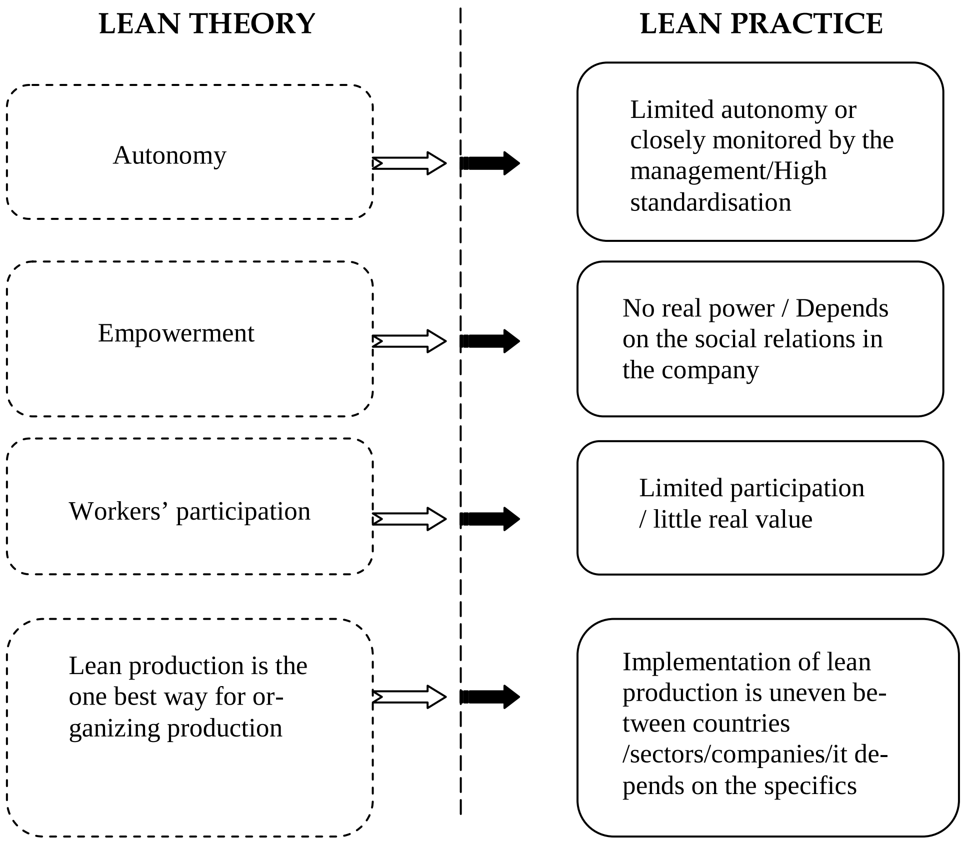
Other authors have sought to explain the failure of lean production to deliver all of its promises and for some researchers the explanation is the partial adoption of its principles by many companies. Lean production applied in manufacturing in various countries differs, for example, from the original lean concept developed in Toyota in the automobile industry in Japan (Smith & Elger, 1998). Ichniowski, Shaw and Prennushi (1997) found evidence, for example, that companies in the US have not adopted all of the institutional aspects of lean production systems in Japan; the most notable absence being the promise of lifelong employment. Therefore some of the potential positive effects of lean production have not been transferred to other cultural environments. Pfeffer (1998), for example, considers employment security a critical element of high-performance work systems such as lean production.

Jones et al., (2013) investigated how managers of lean production plants maintain the illusion of employee empowerment. In the report a case study from a lean plant is used to illustrate the methods applied. The case study dealt with the investigation of sexual harassment incidents. During this investigation worker involvement was suppressed and the problem was handed over to external consultants. Worker involvement was only asked for to establish a set of company values and consensus was reached when the values reflected the views of the managers. Thus, the authors suggests, an illusion of worker empowerment was created. Finally the solutions suggested (a corporate hotline direct to the President's office and establishing mini-Human Resources teams in manufacturing areas) increased management surveillance rather than empowering workers. The authors conclude that this process is common in lean production systems: i.e. there is a consensus decision making process but it is manipulated by the management to favour cost and production solutions. This study is unusual in constructing a theoretical basis to explain why there is a belief that lean production can include employee empowerment but the reality is different. However, it is difficult to generalise from the findings of only one case study.

From these studies it seems there is a rhetoric that lean production can lead to many benefits for workers, including empowerment and job control, but that the reality can be very different. Figure 3 summarises the discrepancies between lean production theory and practice that have been identified by these researchers.

In conclusion, as a result of a review of the promised benefits of lean production, it does not appear by definition to create challenging and fulfilling work. Researchers are questioning whether real empowerment and autonomy can be gained for workers. The standardisation of work processes in lean production methods can hinder empowerment and job control. However, lean implementation is not the same across different companies, sectors and continents and the outcomes can depend upon what is implemented and how.

Figure 3 Benefits of lean production – Discrepancies between theory and practice found in the literature



4.2.2. EVIDENCE ON ADVERSE HEALTH & SAFETY EFFECTS OF LEAN PRODUCTION

Today there are some data available –from US and Europe- to answer questions about the impact of lean production on job dimensions and health. The 36 studies reviewed below that have studied the adverse health & safety effects of lean production systems are mostly from North America and are in the automotive manufacturing industry. However, a number of small-scale surveys investigating effects of lean systems on health & safety are included that have been conducted in Europe, and are in other manufacturing industries or in service sectors.

The studies reviewed investigated associations between lean practices and risk factors like job demands, work pace, ergonomic risk factors; positive outcomes such as decision authority, skill development, autonomy and job satisfaction that if absent or low can be a risk factor, and effects like upper extremities musculoskeletal disorders, fatigue, strain and stress. The majority of lean studies reviewed investigated psychosocial factors and related effects. Some studies examine both psychosocial and ergonomic risk factors and health effects. Finally a few studies look specifically at musculoskeletal disorders (MSDs).

In Table 3 an overview of the results of the studies is given. In total more than half of the lean studies report negative outcomes for risk factors and health effects. One third of the studies have mixed outcomes. In the automotive industry 90% of the studies report negative outcomes whereas in manufacturing mixed effects outnumber the negative ones. Finally in services there is a relatively equal distribution of all types of outcomes.

Table 3: Overview of studies results on lean effects

Sectors	**(+)**	**(+ / -)**	**(-)**	**(0)**	**Total**
Manufacturing	-	6	3	1	**10**
Automotive industry	-	2	14	-	**16**
Services – Mixed sectors	3	2	3	2	**10**
Total	**3**	**10**	**20**	**3**	**36**

Table 4 presents an overview of the 36 studies reviewed and their main findings organised according to sectors. The classification of sectors distinguishes between manufacturing other than automotive (10), automotive industry (16) and services and mixed sectors (10). Studies received marks in the last column, according to the type of outcome they found on risk factors and health effects. Positive outcomes were marked as **(+)**, mixed outcomes, i.e. both positive and negative, as **(+ / -)**, negative outcomes as **(-)** and neutral as **(0)**.

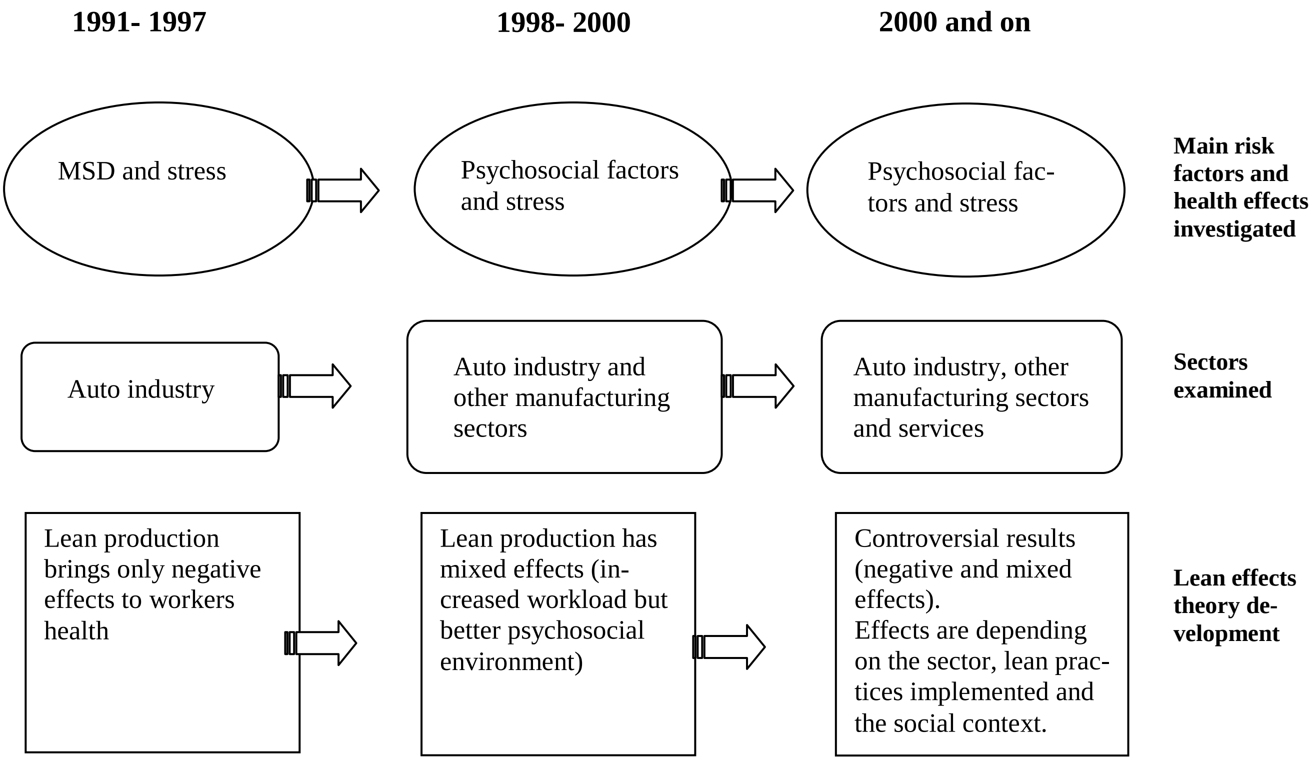


Figure 4: Trend analysis of the lean effects literature

An analysis of trends in the effects of lean production is presented in figure 4. The analysis identifies three time periods in which studies were undertaken when there were different approaches to lean implementation and different findings about the effects of these implementations. The first period is after the implementation wave of lean production in automotive industries in US and Canada (1991-1997). Inevitably the research at this time was carried out in the automotive industry and the focus was on musculoskeletal disorders and stress. The majority of studies report negative effects related to faster work pace, increased upper limb disorders and perceived stress. The second period is shorter (1998-2000) and covers studies carried out mostly in Europe that investigated other manufacturing sectors than the automotive industry. In this period lean production migrated from the automotive industry into other manufacturing sectors and expanded from the USA to Europe. The research focus started to shift from mechanical exposure and health effects such as musculoskeletal disorders to psychosocial factors and stress. The findings from these studies are mixed with some job characteristics negatively affected and others positively. The reason behind the shift from negative effects to mixed outcomes might be that the work characteristics that cause musculoskeletal disorders were not so extreme (work pace, long working hours, etc.) in these manufacturing sectors compared with the automotive industry. Another reason might be that in these manufacturing companies hybrid forms of lean production were implemented rather than the full forms introduced in the automotive industry and that some of the characteristics of lean production that lead to adverse effects were not implemented. In the last period from 2000 to the present the studies were undertaken in a range of sectors that included service organisations that had gradually started to implement lean practices. The results include both negative and mixed effects. The effects may vary because of two factors: first, the sector (e.g. the automotive industry nearly always shows negative effects) and, second, the way lean practices are implemented (e.g. management decisions on which lean practices to implement and how).

As a result of these studies theoretical perspectives on the effects of lean production have evolved through the years. When lean production was first introduced it was presented as an efficient system for production that also had positive effects for workers, increasing their autonomy and empowerment. The first cluster of studies on the effects of lean production led to the conclusion that lean practices were inherently harmful to the workforce. However, the more recent studies in other manufacturing sectors and in the service sector where the degree of lean implementation level was lower demonstrated mixed effects. Consequently new theoretical ideas have begun to emerge that propose that the effects found are strongly associated with specific characteristics of lean production and their implementation. In particular, practices such as Just-in-Time have been identified as responsible for most of the adverse effects on health and safety of workers (Parker et al, 1995, Brenner et al, 2004, Conti et al, 2006, Sprigg & Jackson, 2006).

A more detailed presentation of the main studies reviewed on lean production/Just In Time organisations will follow using a classification of the different effects on health and safety: musculoskeletal disorders (MSDs) in section 4.2.2.1 and job stress in section 4.2.2.2 respectively.

4.2.2.1. Lean production and the development of musculoskeletal disorders (MSDs)

Landsbergis et al. in 1996 and 1999 reviewed several studies that examined records of musculoskeletal disorders in lean production workplaces. The majority of the studies found a moderate association between lean production and Upper Extremities Musculoskeletal Disorders. In industrial settings other than automotive manufacturing the evidence of adverse outcomes was more equivocal. Several case studies, mainly from the automotive industry investigated the specific relationship between increased work intensification and rationalisation of production in lean companies and MSDs. In their case study of CAMI (A Canadian joint venture between GM and Suzuki) Robertson et al. (1993) made a case for such a link. They argued that increased hours led to the number of reported MSDs more than doubling during the years 1992-1994. MSDs rose from 12% to 33% of all reported injuries.

In the NUMMI (New United Motor Manufacturing, Inc.) case study (Adler et al., 1997), it was reported that during lean implementation, absences due to health & safety problems increased by 12%. Treece (1989) found that workers at the NUMMI plant worked 55 seconds out of every minute.

In a more recent study (Brenner et al., 2004) matched data on workplace transformation (e.g., Quality Circles, work teams, TQM, job rotation and Just-in-Time production) at a number of establishments with measures of MSDs at these same establishments to explore the relationship between "flexible" workplace practices and workplace health and safety. This study established a positive, statistically significant, and quantitatively sizable relationship between MSDs and the use of Quality Circles and Just-in-Time production. These two work practices collectively accounted for 50% of the mean MSD rate in these companies. The proposed explanation of the positive relationship between MSDs and these lean practices was that Just-In-Time inventory and Quality Circles led to reduced cycle times, speed ups and ill-fitting parts that increased worker responsibility and reduced worker empowerment. The results further suggested that these two practices had more pronounced effects when they were applied together rather than exist separately in establishments. This study is noteworthy because of its large sample (no of establishments=1,848) and the strength of the findings. However, whilst attention is paid to the mechanisms by which Just-in-Time can have negative results no explanation of how Quality Circles lead to negative effects is provided.

A problem in monitoring work–related health effects such as MSD complaints in lean environments is under-reporting. In lean production work is organised in teams. In teams the cost of an absence is high, because the absence of an individual not only means the loss of this person' production, but affects the productivity of others. Workers in lean teams tend to refrain from reporting injuries or asking for sick leave. Adler et al., (1997) suggested that in automotive industries there was a climate that encouraged working in pain. Berggren et al., (1991) in their study of automotive plants in North America also reported peer pressure to 'work in pain' and not report injuries.

Christmansson et al., (1999) reported that lean redesign introduced more tasks for assembly workers (including material handling, set up of equipment and administrative work). Increased task variation combined with lack of skill and competence, increased physical stress and risk of disorders. However, there was no change in the prevalence of MSD symptoms. This study makes an interesting comparison of an assembly line before and after redesign implementing lean practices. A limitation of the study is the fairly small sample.

Womack et al., (2009) in a recent study compared a lean automotive plant with a traditional one. They examined the relationship of lean job design with musculoskeletal risks. Repetition was found to be higher at the lean plant (p=0.001). The mean rating for repetition was 5.5 compared to 5.0 at the traditional plant based on the hand activity level (HAL) scale (Latko, 1997). However, peak hand force was lower at the lean plant and awkward postures were not statistically different for the two plants (p=0.05). The overall conclusion was that there was no difference between the total risk index for the lean plant and that of the traditional plant.

Lloyd and James (2008) in a study in the food processing industry described a customer-controlled Just-in-Time system that was integrated into the supply chain. High prevalence of upper limb disorders was reported due to repetitive jobs and increase in work pace. A recent study investigated impact on mechanical exposure for dentists due to rationalisation in public dental care in Sweden (Jonker et al., 2013). Particularly flexion/extension of the head, trunk and upper arm elevation were recorded during value added work and non-value work (waste) activities. The recordings were made in 2003 and 2009 after the implementation of rationalisation. No major differences were found between baseline and follow up. However, although as a result of rationalisation initiatives waste activities were expected to be reduced, in this study they showed an increase. Accordingly, no major changes in mechanical exposure at the job level could be shown.

In conclusion lean production especially in the automotive industry is associated with increased MSD symptoms of workers particularly in earlier studies. The reported results may reflect 'rigid' lean implementation strategies applied in the automotive industry in the 1990s and may be the result of increases of work pace and lack of recovery time in lean companies caused by Just-in-Time systems. Moreover, pressure from team working may have prevented workers from reporting their symptoms and forced them to work in pain. Studies in other manufacturing sectors implementing lean production have provided some evidence for an increase in musculoskeletal risk factors but not for an increase of MSD prevalence. Longitudinal studies are required to study the long-term effects of lean manufacturing.

4.2.2.2 Lean production and effects on job stress

There is an extensive research literature on the relation between job stress and lean production and the results are often contradictory. Several studies are ethnographic analyses of Japanese automotive plants in the US (Conti et al., 2006). These papers depict fast paced, high intensity, high stress environments. Berggren (1993) characterises lean production in automotive industry as 'mean production'. According to Berggren the experience of Japanese lean production transplants to the US has been problematic. Specifically the 'mean' characteristics of lean production were relentless performance demands, unlimited working hours and a rigorous factory regime. Also Niepce and Molleman, (1998) have criticised the type of lean production developed in the Japanese car industry. They have pointed out that some key features of lean production, such as continuous flow of production and lack of buffers result in time pressure and stress.

Researchers have raised the question of whether lean production is deterministically stressful and that the benefits gained are at the expense of workers (Bruno and Jordan, 2002, Brenner et al., 2004, Lewchuck et al., 2001). Some other studies at about the same period were more favourable to lean production. In a longitudinal study in the UK (Mullarkey et al., 1995) it was concluded that it is possible to introduce Just-in-Time and team working without detrimental effects on operator's psychological well-being. In a comparison of lean and traditional lines at a UK board plant (Jackson & Martin, 1996) Just-In-Time was found to be implemented without adverse impact in terms of employee strain. However, the study showed a reduction in timing control when Just-in-Time was implemented that could lead to psychological strain. This is a comparative pre-post study that is beneficial for examining lean effects.

Quite recently new studies 'sympathetic' to lean production have started to re-emerge. These studies question whether lean production is inherently stressful and look for correlations between stress and specific lean characteristics and practices (Conti et al., 2006, Taylor & Taylor, 2008). In the Conti et al. study (2006), one of the few large scale, multi-industry studies of lean production companies, the relationship between stress levels and lean production implementation was investigated. Total job stress was the sum of the physical and mental stress levels, which was measured by the ASSET survey instrument (Faragher et al., 2004). The results indicate that lean production is not inherently stressful and that there is no deterministic link to worker well-being. Stress outcomes depend heavily on management choices in designing and operating lean systems. The study was based on the Karasek job stress model (Karasek and Theorell, 1990). This model incorporates the effects of job demands, job control and job support. In total 20 lean practices that correspond to job demand, job support and job control were tested for correlation with stress. Eleven practices were significantly related to stress (statistical significance p=0.05 or less). In particular the significant job demands with positive correlation to stress were: work pace/intensity (p<0.001), resource removal (p<0.009), working longer than desired hours (p<0.001), cycle time (p<0.002), doing work of absent workers (p<0.002), feeling blame for defects (p<0.001) and ergonomic difficulties (the degree of difficulty in accessing, handling and positioning components in completing tasks) (p<0.001). Working overtime had the strongest relationship with stress. Long hours created both higher physical job demands and lower control over personal time. The ergonomic difficulties experienced in performing tasks had the second strongest positive correlation with stress. The relationship of work pace/intensity to stress was the third largest correlation. The intensity levels reported by workers, in the ASSET questionnaire, were quite realistic compared to the ones observed on plant tours. Also the relationship between stress and the degree to which worker's felt to blame for defects is noteworthy considering the low frequency of defects in lean production. It appears that the blame feeling persists long after actual defect episodes. Finally, workers experience increased pace and intensity when performing both their tasks and those of absent workers.

The job support dimensions, team working (p<0.001) and task support (p<0.005), had significant negative relationships to stress (as job support was increasing, job stress was decreasing) and lack of adequate tools had a positive correlation to stress (p<0.010) (as lack of adequate tools was increasing, job stress was also increasing). Team working also had a negative relationship to stress. It appears that the positive support of teams outweighs their shortcomings. Also task support from co-workers and supervisors reduces job demands and subsequently stress. The job control dimension, worker participation in process improvement, had a significant negative relationship with stress (p<0.009). Total implementation lean level was also tested for positive relation with job stress (lean level hypothesis). An unexpected nonlinear response of stress to lean implementation was identified. At the initial stage stress is increasing until a certain point. Further implementation is associated with decreasing stress.

This hypothesis was rejected since the relationship between lean implementation and job stress is more complex than hypothesised.

The main value of this study lies in the fact that it systematically tested all lean practices and their correlation to stress. It sheds light on particular conditions where lean production can be stressful to workers. Moreover it directly assessed job stress with the ASSET questionnaire in contrast to other studies that usually only assess psychosocial factors. However, the authors conclude that the stressful practices do not appear to be a necessary condition for achieving the benefits of lean production. It is debatable whether this is valid. Some of the lean practices that were positively correlated to stress are fundamental to lean implementation such as work intensity caused by reduced cycle time. Other authors have blamed these practices for increasing stress in lean systems.

Schouteten & Benders, (2004) also used the Kararek's Job Demand – Job Control model to evaluate quality of working life in a lean bicycle manufacturing plant in the Netherlands. Positive and negative results were also found in this lean environment. Job content was hardly challenging (short cyclical and routine tasks) but there was enough control capacity to deal with problems. Still job control in general was found to be low. Regarding the health outcomes workers reported a great need for recovery. This can be explained by the fact that the work in the factory was physically exhausting due to the repetitive short cyclical work. The takt time was very short at 1 minute. Also workers reported rather low job satisfaction and commitment. However, very few workers reported an intention to resign. The sample of the study was relatively small.

In conclusion some characteristics of lean production seem to correlate with stress of workers, namely reduced cycle time, reduction of resources, mistake proofing, standardised tasks particularly if job control is low and some aspects of team working if no support is provided among co-workers and supervisors. The strongest correlations with stress were found for Just-in-Time characteristics of lean production related to reduced cycle time and reduction of resources.

4.2.2.3 Lean production and occupational safety

Safety effects of lean production and similar management schemes have not been examined extensively by researchers. In theory lean plants place considerable emphasis on safety and the avoidance of accidents, which can interrupt production. Accidents must be avoided at all costs in lean production systems. Also it is proposed that the detailed breaking up of work in tasks and sub-tasks, executed according to specific instructions in such a way so as to be carried out by inexperienced workers, prevents mistakes and therefore near misses or accidents (Koukoulaki, 2010). Other studies have suggested that supervision helps to reduce work injuries. Rinefort et al, (1998) in his study on the effects of organisational downsizing on safety found that when the levels of supervision were increased the injury rates were reduced. The author concluded that the cost savings from the reduction of injuries covered the costs of increased supervision. Lean production reduces unnecessary human resources, in similar ways to downsizing. Supervision, although not completely abandoned in lean companies, is reduced as it is one of the many skills that the groups are expected to acquire. Therefore it can be concluded that lean practices that reduce supervision can have a negative impact on safety.

Landsbergis, Chill and Schnall (1999) found detrimental effects on injury rates in a variety of industries that were implementing lean production. The authors have reviewed studies that examined records of total injuries in lean workplaces. “At a Japanese-owned auto plant in United States (Jidosha), following the start of full-speed production, injury and illness rates for 1988 were 44.4 (per 100 full time employees), 66% higher than the rate for auto plants employing 100 or more workers”, (Wokutch, 1992).

Stoop and Thissen (1997) argued that highly articulated transport systems with narrow time windows for service or delivery, such as Just-in-Time systems, are not conductive to safety. As mentioned above JIT is a main component of the lean system. Stoop and Thissen’ overview described a number of trends in transport systems and their possible effects for transport safety with specific reference to Dutch road safety. Among the identified trends of the transport system, the increase in transport intensity and operational pressures had a negative impact to safety. «For example drivers who see themselves behind planned schedule will give highest priority to catch up with the desired time schedule, often at the expense of safety margins» (Stoop and Thissen, 1997). The paper concludes that changes and trends in complex transport systems do not improve safety on the contrary.

Zacharatos, Barling and Iverson (2005), carried out two studies investigating the relationship of high performance work systems (HPWS) and occupational safety. HPWS incorporate some lean production practices in combination with human resources practices to achieve employees' commitment more effectively. Wood and Wall (2002) «conceptualised high-performance work systems as a group of separate but interconnected human resource practices that together recruit, select, develop, motivate, and retain employees». Way (2002) suggested that this is achieved by ensuring that employees posses a broad range of superior skills and abilities that are used at work, …», (Zacharatos, Barling and Iverson, 2005, p 77).

In the first study by Zacharatos, Barling and Iverson (2005), human resource and safety directors participated from 138 organisations applying ten HPWS practices. These practices composed a single index measuring the HPWS (Confirmatory Factor Analysis was conducted) and comprised of employment security, selective hiring, extensive training, self managed teams, reduced status distinctions, information sharing, compensation contingent in safe performance, transformational leadership, high quality work and measurement of management practices that increase employees' levels of trust in management and perceived safety climate. It was found that HPWS practices were positively related to occupational safety as initially hypothesised. High Performance Work Systems were related to fewer lost time injuries and therefore were a predictor of safety performance (accounted for 8% of the variance of the injuries).

The second study addressed some issues identified in the first study such as the single-source nature of the data and the question of by what ways HPWS affect safety.

Zacharatos, Barling and Iverson proposed a 3 paths model on how HPWS affects occupational safety. HPWS can increase trust in management and thus reduce safety incidents requiring first aid and near misses. In parallel HPWS can improve the safety climate and subsequently increase the personal safety orientation of employees (safety compliance, safety knowledge, safety initiative and motivation, etc.). Moreover an improved safety climate can have a direct negative effect on safety incidents.

To test the model, two organisations from petroleum and telecommunications industries participated in a second questionnaire study with a sample of 196 employees. HPWS had a positive relation with perceived safety climate ($p<0.01$) that had a negative effect to safety incidents ($p<0.01$) and a positive effect to personal safety orientation ($p<0.01$). Trust in management on the contrary mediated the effects of HPWS to safety incidents ($p<0.05$) but not the effects on personal safety orientation that was found not significant.

Both studies in high performance organisations confirmed that organisational factors have a stronger effect on occupational safety compared to personal attitudes and characteristics (personal safety orientation).

In conclusion specific lean policies such as standardization and mistake proofing can improve safety. However in practice; factors intrinsic to lean production such as reduction of supervision can indirectly cause safety to deteriorate. High Performance Work Systems, that apply lean practices although they differ in their Human Resources approach, were found to affect occupational safety positively with main mediators being trust in management and the perceived safety climate.

TABLE 4: OVERVIEW OF LEAN PRODUCTION STUDIES INVESTIGATING RISK FACTORS AND HEALTH OUTCOMES

Authors/Editors	Study Design	Sector	Outcome measure	Results
		MANUFACTURING OTHER THAN AUTOMOTIVE		
Bao et al., 1997	Cross sectional study	Manufacturing {Cassette recorders assembly vs assembly of sewing machines (lean practices)}	Mechanical exposure measures, Rest pauses	Higher frequency of upper arm movements, faster work pace, reduced rest pauses **(-)**
Christmansson et al, 1999	Pre-post	Manufacturing (Door and windows handles production) before and after lean	Ergonomic factors, upper limb MSD prevalence, autonomy, control, variety and job satisfaction	No changes in MSD prevalence **(0)** Increase in manual handling and frequency of movements, mixed effects on psychosocial factors (+ / -)
Conti et al, 2006	Cross sectional study	Metal industry and electronics	Job stress	Lean production was not found inherently stressful and stress levels were significantly related to management decisions in designing and operating lean production systems. In particular eleven work practices were found to be significantly related to job stress. (+ / -)
Jackson & Martin, 1996	Pre-post study	Electronics	Demands, production pressure, control, job satisfaction, psychological strain	Reduction in control over work timing, increase in production pressure, drop in job satisfaction. No change in control over work methods, cognitive demands and psychological strain. **(-)**
Jackson & Mullarkey, 2000	Cross sectional study	Garment manufacture	Demands, autonomy, social climate	Both positive and negative effects on autonomy, work demands and social climate. (+ / -)

Authors/Editors	**Study Design**	**Sector**	**Outcome measure**	**Results**
		MANUFACTURING OTHER THAN AUTOMOTIVE (continue)		
Lloyd and James, 2008	Historic perspective	Food processing	Upper limb disorders prevalence, work pressure	High prevalence of upper limb disorders, increased work pressure **(-)**
Mullarkey et al, 1995	Time series	Electronics	Demands, control, coworker support, job satisfaction, psychological strain	Introduction of JIT was associated with no change in existing levels of employee autonomy, job demands and employees strain **(0)**
Saurin & Ferreira, 2009	Historic perspective	Assembly workers	Work pace, workload, general working conditions	Work pace and workload were increased, general conditions improved **(+ / -)**
Schouteten & Benders, 2004	Case study	Bicycle manufac-turing	Demands, control, job satisfaction, commitment	Job control was found low. In general job demands were found low. However takt time was very short and the need for recovery was report-ed high. Workers reported rather low job satisfaction and commitment. **(+ / -)**
Seppala and Klemola, 2004	Historic prospective	Metal industry	Time pressure, psychological strain and stress	Blue collar and white collar employees often had experienced time pressure at work. The white collars employees and some blue collar (maintenance and material workers) experienced their work as mentally strenuous and stressful. **(+ / -)**

Authors/ Editors	Study Design	Sector	Outcome measure	Results
AUTOMOTIVE MANUFACTURING				
Adler et al, 1997	Longitudinal	Auto industry	MSDs, stress	Absences due to health & safety problems increased by 12%. Within the first month of production upper limb disorders more than doubled and back and neck cases increased 7 times **(-)**
Babson, 1993	Historic prospective	Auto industry	Workload	Workload increased after introduction of lean practices **(-)**
Berggren et al, 1991	Case study	Auto industry	Stress, MSDs	Reported high levels of perceived stress and of musculoskeletal disorders, due, in their opinion, to the fast work pace, long work hours, highly repetitive work, and limited rest breaks. **(-)**
Brenner et al, 2004	Cross sectional study	Auto industry	MSDs	JIT and quality circles are both positively and statistically significantly associated with MSDs rates across establishments. **(-)**
Bruno & Jordan, 2002	Cohort study	Auto industry	Empowerment, skills utilization, involvement, job control,	In the 1989 study 50% had a positive attitude about management and work environment. In 1997, 96% found work life negative. There was universal discontent with Quality circles, nearly 50% had negative impression of kaizen, 30% complained that work has become more 'physically rigorous' and safety was neglected. **(-)**
Graham, 1995	Case study	Auto industry	MSDs	Increased hand and wrist injuries due to increase of line speed. **(-)**
Leroyer et al, 2006	Time Series	Auto industry	Health of workers, job demands	Reduced heath, psychological and physical demands increased **(-)**
Lewchuk & Robertson, 1996	Cross sectional study	Auto-assembly companies	Workload	Workers reported increasing and faster workloads compared to Fordism plants. **(-)**
Lewchuk & Robertson, 1997	Cross sectional study	Auto industry	Work pace, job demands	High work pace, Increase in job demands with level of lean **(-)**
Lewchuck et al, 2001	Comparative study	Auto industry	Job control, workload, health & safety conditions (pain or discomfort, ergonomic stressors, exhaustion)	Lean production is not associated with increased empowerment or greater employee control over work. On the contrary employees report quite different experiences of work effort, health & safety and relations with management **(-)**

Authors/ Editors	Study Design	Sector	Outcome measure	Results
		AUTOMOTIVE MANUFACTURING		
Mehri, 2005	Qualitative	Auto industry	Injury and illness reports, workload	High reports of injuries and illnesses, high workload **(-)**
Parker et al, 1995	Case study	Car seat manufacture	Work load, psychological strain	JIT increased employee work load (not in cognitive demand) and psychological strain. (-)
Parker, 2003	Longitudinal study	Assembly of large vehicles	Job autonomy, skill utilization, participation in decision making, psychological strain (job anxiety & job depression)	Employees in lean production groups had declines in job autonomy, skill utilization and participation in decision making. Job depression was increased. **(-)**
Parker & Sprigg, 1998	Longitudinal study	Auto manufacturing (truck)	Job control, skill variety, demands, job satisfaction, workload, job strain	Workers reported reduced autonomy & task variety, increased stress, decreased job satisfaction and reduced organizational commitment. Employees involved in the cell certification process had positive mental health outcomes, especially where there were high levels of management support. (+ / -)
Robertson et al, 1993	Case study	Auto assembly plants	Workload, MSDs, stress	Reported MSDs were doubled between 1992-1994 due to increased hours and overburdened jobs. Increased stress (40%). **(-)**
Womack et al, 2009	Cross sectional study	Auto industry	Ergonomic risk factors	More repetitive jobs, lower peak hand force ratings, same demands in postures, no difference in the overall risk index **(+ / -)**

Authors/ Editors	Study Design	Sector	Outcome measure	Results
		SERVICES – MIXED SECTORS		
Batt & Appelbaum, 1995	Cross sectional study	Customer service and network craft workers	Job satisfaction	Higher job satisfaction in self managed teams when dependence from other teams was low **(+)**
Batt, 2004	Cross sectional study	Telecommunications	Job satisfaction	Self-managed teams reported more job satisfaction **(+)**
Carayon et al, 1999	Cross sectional study	Office work	Workload	TQM increased workload but improved other psychosocial factors **(+ / -)**
Härenstam et al, 2000	Cross-sectional study	Mixed sectors (services and manufacturing, private and public sector)	Workload, work control, support and development possibilities	80% working in lean production workplaces reported increased workload, 40% reported increased work control **(-)**
Harley, 2001	Cross sectional study	Mixed sectors	Stress, job satisfaction	No effects of teams in stress or job satisfaction **(0)**
Karia & Asaari, 2006	Cross sectional study	Mixed sectors	Job satisfaction	Higher job satisfaction with training and empowerment **(+)**
Klein, 1991	Comparative study	Auto industry, engine manufacturing and instrument manufacturing	Job autonomy	JIT and standardisation practices offer limited autonomy to workers **(+ / -)**
Sprigg & Jackson, 2006	Cross – sectional study	Call centers	Job autonomy, skill utilization, workload, role conflict, job clarity, task variety, job strain	Employees who practice certain lean characteristics (greater dialog scripting and more intensive performance monitoring) experience higher levels of strain. Dialog scripting is also associated with lower autonomy, lower task variety and skill utilization, lower role clarity, higher workload, and higher role conflict. **(-)**
Vendramin et al, 2000	Empirical Case studies (Belgium, Denmark, France, Italy, UK, Spain)	Printing and publishing, civil engineering, banking and insurance and health services	Work pace	New rhythms of production can cause intensification of work. **(-)**
Jonker et al, 2013	Prospective cohort study	Public dental care	Mechanical exposure (flexion/extension of the head, trunk and upper arm elevation), duration of value added and non-	No major differences between baseline and the follow up (0) The value added work activities that could lead to an increase in mechanical risk factors were reduced instead of increased during rationali-

			value added work activities	sation.

4.3. A PATHWAY FROM LEAN PRODUCTION TO STRESS, HEALTH EFFECTS & POSITIVE OUTCOMES

In this section an interaction model is proposed illustrating the relations between lean practices and risk factors. Figure 5 demonstrates a pathway from the lean characteristics to the musculoskeletal and psychosocial risk factors and also to positive outcomes. Two models of the basic risk factors leading to psychosocial (Karasek & Theorell, 1990, Siegrist, 1996) and musculoskeletal health effects (Bongers et al., 1993, Bernard, 1997, Devereux et al., 1999, Punnett & Wegman, 2004, Silverstein et al., 1996) are presented in the left and right columns of the table. In the central column the basic lean production characteristics are linked to subsequent effects on job characteristics. These new job characteristics result in exposure to specific risk factors in the psychosocial and musculoskeletal models. This model was inspired by the general models of Westgaard & Winkel, (2011) (figures 1 and 2, p. 266 & 267 respectively). The associations depicted are based on the findings of this literature review.

In the introduction (Table 1) a set of basic lean characteristics is presented. However in this pathway only the lean characteristics that had negative or positive association found on the literature will be illustrated. These are JIT, standard operating procedures, TQM & quality circles, mistake proof and autonomous groups. Lean characteristics such as waste reduction, Just-In-Time and standardised work, all aimed at maximising efficiency within the cycle time, cause intensification of work that is linked with both basic psychosocial and mechanical exposure to workers.

Conti et al (2006), linked JIT practices with reduced cycle time, removal of resources, increase of work pace and stress. Parker et al, (1995) found that JIT increased work load. Seppala and Klemola, 2004, associated waste reduction in lean production with time pressure. Brenner et al (2004) and Berggren et al, (1991) found associations between JIT and increased MSDs due to reduced cycle times. Nonetheless some types of waste reduction namely motion and transportation waste can have positive effects that reduce several mechanical risk factors for MSDs such as awkward postures and manual handling. However, manual handling in lean plants was found to be increased in two of the studies.

Schouteten & Benders, (2004) found a very short takt time in lean environment. Sprigg & Jackson, 2006 found correlation with standardised operating procedures and stress. Parker (2003) related standardization with job strain in lean assembly workers. Robertson et al. (1993) associated overtime work with increased MSDs. In Conti et al (2006) working overtime had the strongest correlation with stress.

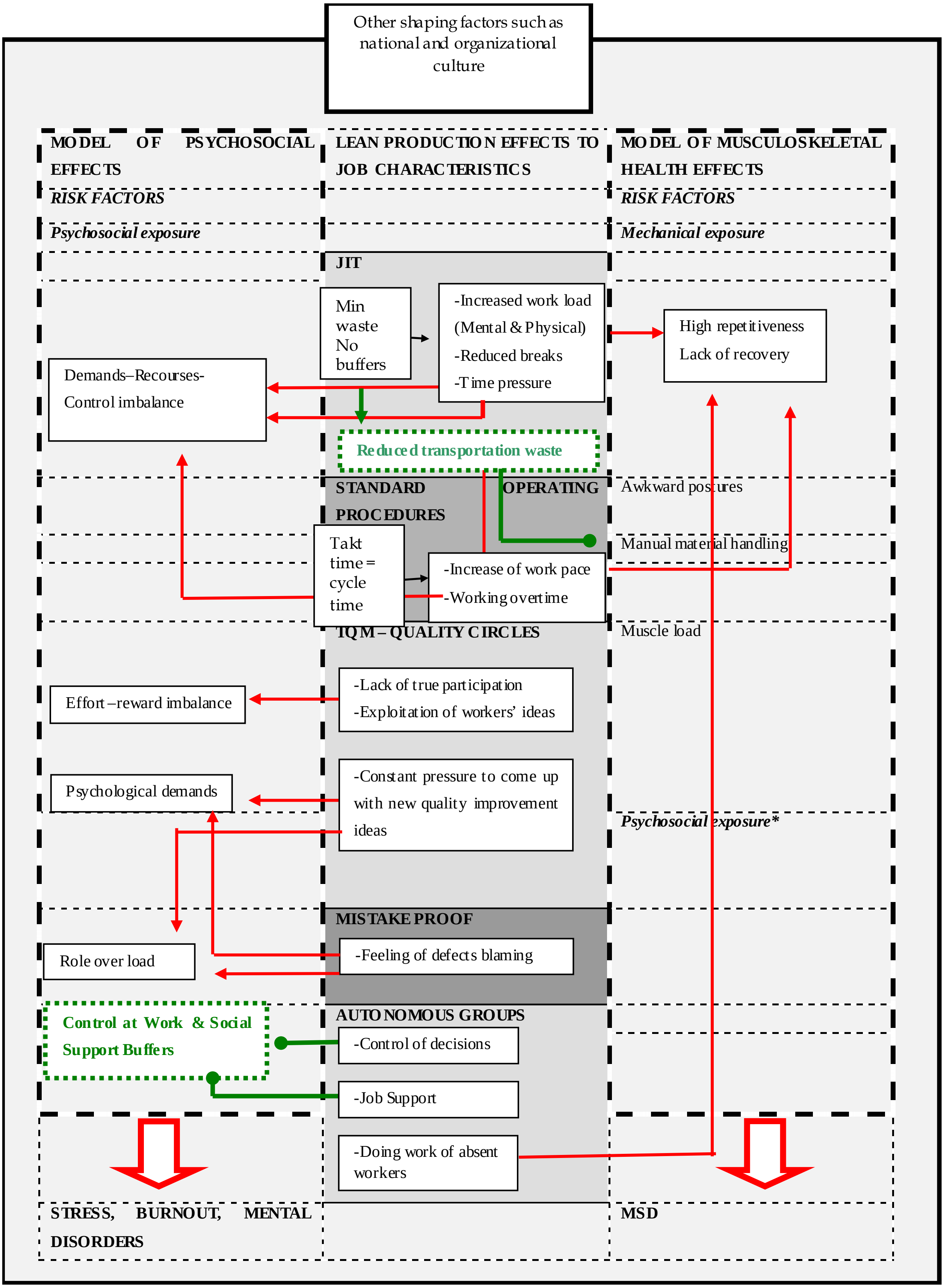
Other lean characteristics such as Total Quality Management and 'Mistake proofing' seem to expose workers to different psychosocial risk factors such as effort-reward imbalance and role overload. Conti ei al (2004) found workers feeling blamed for defects associated with stress. Bruno & Jordan, (2002) found that workers' ideas during quality circles were not followed or were stolen by the management. Salvendy (1997) warned about the effects of the obligatory nature of the improvement ideas in quality circles.

On the other hand, lean characteristics can also be connected to positive job characteristics such as 'control of decisions' and 'job support' that act as buffers to the psychosocial effects and stress (marked green in the model). That is, if genuine control of decisions at work and social support from team colleagues and supervisors is possible within the autonomous groups of lean production. The clarification in control at work (control of decisions) is made here since only some aspects of control can be achieved. Control of work pacing is not possible in lean systems. Conti et al (2006) identified job support dimensions that had a negative relationship with stress. Also Jackson & Martin, (1996) found team support to be a mediator of stress. Results on the positive effects of job control in lean environments were contradictory among researchers: however they will be tested in this interaction model.

What is apparent from this model is that lean production has a greater impact on work-related stress compared to musculoskeletal disorders. That is because lean characteristics influence concurrently a number of psychosocial risk factors that have a direct effect on workers.

Other shaping factors such as the national and organisational culture (management of change, organisational learning, worker participation, etc.) can have also negative and positive effects to workers' wellbeing. These factors can also influence the way lean production is implemented.

The influence of these factors is presented in the pathway on the outer line in the figure 5 but these factors are not controlled in the study.



*Psychosocial factors can also have musculoskeletal effects

Figure 5: Interaction model of lean production effects to job characteristics and their relation to musculoskeletal and psychosocial risks

4.4. DISCUSSION

The current study made a literature review across the last 20 years (1990- 2013) and has included several studies of lean production effects in automotive manufacturing and other sectors (Conti et al., 2006, Leroyer et al., 2006, Lloyd & James, 2008, Mehri, 2005, Parker, 2003, Saurin & Ferreira, 2009, Schouteten & Benders 2004, Seppala and Klemola, 2004, Sprigg & Jackson, 2006, Womack et al., 2009, etc.).

Overall the findings of the surveys and literature reviewed indicate that the effects of lean production on working conditions are more evident in the automotive industry (increased stress and symptoms of MSDs) and less evident in other manufacturing sectors. In manufacturing an increase in workload was observed for half of the studies but not always linked to increased strain. Other studies demonstrated either no change (Mullarkey et al., 1995) or both negative and positive effects of lean production on workers (Conti et al., 2006, Jackson & Mullarkey, 2000, Saurin & Ferreira, 2009, Schouteten & Benders, 2004, etc). In services and other sectors the outcomes seem to be more balanced. It is in this section that all the positive outcomes have been reported. These positive outcome studies describe self-managed teams and empowerment of workers.

Parker (2003) has attributed these inconsistencies in the findings to the problem of what constitutes lean production and how it is implemented because this varies considerably among studies. Lean production was originated in Toyota in Japan and then transferred to US automotive plants. So it is logical that in the automotive industry the lean implementation is full and its effect on working conditions may be expected to be more evident. Moreover some organisations introduce hybrid forms that include aspects of lean and other production systems. Such forms are more prevalent in manufacturing and other sectors.

Parker (2003) concluded that lean production is likely to have different consequences for work characteristics depending on the different elements of lean production that are introduced. In particular in her study the installation of a moving assembly line was associated with severe negative effects on work characteristics and employee outcomes (increased job depression) compared to lean teams and workflow formalisation and standardisation (inventory reduction and processes simplification and standardisation) that had negative but not so extreme effects. Conti et al. (2006) identified eleven particular work practices significantly related to job stress. The most important were work pace/intensity, resource removal, working longer than desired hours, cycle time, doing work of absent workers, feeling blame of defects and ergonomics difficulty.

The characteristics of lean production that seem to have overall the strongest association with negative effects on workers in this study are Just-In-Time practices such as removal of waste and non-value activities. It appears that these practices are causing intensification of work that is linked to increased levels of strain and stress. Parker and Conti are part of a new school of thought in lean production research, advocating that lean production is not by definition harmful. Specific lean characteristics can have adverse effects on work characteristics and workers' health. Moreover what are of great importance are the choices companies make in lean implementation. For instance a company could choose to apply one lean characteristic to its extreme, (e.g. removal of 'waste activities'), that has a direct effect on work intensification, while minimising other characteristics that could act as a buffer to stress (e.g. autonomy and group support in teams). This dangerous combination could only bring about the unfavourable effects of lean production.

In their review Westgaard & Winkel (2011) investigated potential 'conditions of work' mentioned as modifiers that could alleviate lean effects. The most important ones were group autonomy, social support at work and worker participation when a lean system is introduced and in improvement programs.

The analysis of studies made in different periods of time showed the changing trends in both the application of lean practices and the effects on workers over a 20 year period. Theories of the effects of lean production effects have evolved from a view that it is an inherently harmful management system to a system that can have mixed effects depending on management style and the way it is implemented. However, there are specific lean practices that lead to negative effects that are fundamental to lean production and cannot be omitted if lean methods are claimed to be adopted. The underlying mechanism of lean production, as illustrated in figure 5; is intensification of work. Just-in-Time practices are causing intensification of work and they are the practices that trigger negative health effects.

In conclusion, recent research on lean production reported that negative effects on workers are strongly associated with some lean practices. Specific lean practices such as Just-in-Time and standardised work cause intensification of work and are strongly associated with both mechanical and psychosocial exposure. However, this cannot lead to the conclusion that lean production is not by definition harmful. Waste reduction practices are considered to be the core of lean production and without them a production system can hardly identify itself as lean. Not all lean characteristics are harmful but the core ones can be harmful if no buffers (such as job control and social support) are applied. In conclusion it is not only the level of lean implementation that correlates to risk factors but also the type of lean characteristics that are applied. The main underlying mechanism for the health effects of lean production is the intensification of work that in some cases is unavoidable.

5. FIELD STUDY

5.1 METHOD STATEMENT

5.1.1 INTRODUCTION

This research is going to investigate the effects of production optimisation systems such as lean systems on health & safety. In particular the research will examine the effects of lean production on stress and MSDs

The main research question was whether lean production has consequences for psychosocial factors and MSDs. In an effort to connect stress with specific job characteristics linked with lean production the first three hypotheses investigate the relationship of stress with (1) job demands, (2) performance monitoring and (3) job control in lean environments. These hypotheses are based on the Job Demand/Control Stress Model (Karasek, 1979). The fourth research hypothesis is that (4) the level of lean production can increase stress since it can combine many risk factors such as increased work pace, limited control of work, high standardization, etc. The lean production variable was not treated as a 'yes or no' system but as levels of implementation (leanness) as this reflected more the reality. It is suggested here that the leaner the work environment (high lean implementation level) the higher should be the job stress. The fifth research hypothesis investigated (5) the relationship of leanness with quantitative demands. The relationship between MSDs and quantitative demands, performance monitoring and stress in lean environments was examined in hypotheses 6 – 8.

Analytical the statistical hypotheses are:

Hypothesis 1: Job stress is positively related to quantitative demands in lean establishments

Hypothesis 2: Job stress is positively related to performance monitoring in lean establishments

Hypothesis 3: Job stress is negatively related to job control in lean establishments

Hypothesis 4: Job stress is positively related to the level of lean implementation

Hypothesis 5: Quantitative demands are positively related to the level of lean implementation

Hypothesis 6: MSD symptoms are positively related to quantitative demands in lean establishments
Hypothesis 7: MSD symptoms are positively related to performance monitoring in lean establishments
Hypothesis 8: MSD symptoms are positive related to stress in lean establishments

The main independent variable in the study is the level of lean implementation and the dependent variables are psychosocial risk factors and stress. Moreover psychosocial factors linked to lean production (e.g. quantitative demands and electronic monitoring) are independent variables in other hypotheses where the dependent variables are job stress and MSD symptoms. MSDs were not examined in relation to leanness because not all companies in the sample completed the relevant questionnaire.

Case studies were selected as the research method. This decision was taken for several reasons. First, case studies allowed for in-depth study of the companies. Secondly, lean production practices are not clearly defined and straightforward in companies; therefore sampling would be tedious and not representative particularly in Greece where the study mainly took place. Finally, the topic of the PhD was not attractive to many companies who were reluctant to permit investigation of the potential effects of lean production on their workers. Therefore a limited number of cases (five or six) was the initial goal. It was decided to form a heterogeneous sample and find cases from different sectors and various levels of lean application. The variation in lean application proved to be very useful in the study since the research aimed to identify the different consequences of different lean environments. Recent literature (Conti et al., 2006) has indicated that lean production is not inherently stressful and stress levels are significantly related to management decisions in designing and operating lean production systems. For that reason a lean classification model was required. An existing validated model from the literature was adopted and applied to the study.

The initial aim was to compare control groups in lean companies which are not exposed to lean practices with equivalent departments where lean practices had been applied. Although great efforts were made in this direction it was not possible in this study. The most obvious reason was that lean companies rarely have workers who are not exposed at all to lean practices because there is considerable interaction between departments. Moreover, the companies of the sample did not allow extended distribution of questionnaires as this would raise issues among workers. In general, the process of finding lean enterprises and getting them to agree to participate was very time-consuming; more than was initially anticipated. Very few 'lean' associations and professional clubs were found in UK and they refrained from providing information on their members or participating in this study. One "advanced lean" shipyard in UK declined after having agreed to participate, give interviews and questionnaire distribution. The reason was a last minute fear that participation would destabilize delicate social relations. Two "nominal lean" companies from the tobacco industry in Greece that were initially selected were abandoned after failing to fit in to the lean classification system.

The cases studies selected for the field study were five. Three were from manufacturing (a large multinational beverage company, a company constructing aluminum profiles, an electronics company) and two service companies: both telecommunication call centres. The first four companies were located in Greece and the last in UK. Although call centers belong to the services sector their organization structure is Just-in-Time because information and technical services are client- oriented and delivered the minute they are requested. Considerable effort is devoted to waste reduction and that, in this case, is delays in response. Cycle times in call centres are rather short (call handlers are required to complete calls in less than two minutes). Moreover Sprigg & Jackson (2006) have identified other lean characteristics in call centres such as process simplification and standardization that is achieved through dialogue scripting and performance monitoring that is traditional and electronic in call centres. Findings from the study by Sprigg and Jackson show strong relationships between lean characteristics in call centres and job related strain.

The sample was treated as two clusters, the manufacturing and the services. The three industries were merged in the manufacturing cluster and the two telecommunication companies were merged to the services cluster. There was first a statistical control between companies to test significant differences for job characteristics, stress and job satisfaction. Significant differences for some job characteristics were found between manufacturing companies. However the author proceeded into merging the three manufacturing companies in one cluster since studies that compare lean effects between services and manufacturing are scarce in the literature. The other reason was to increase the sample in manufacturing to make meaningful statistical controls. The research hypotheses were tested for each cluster and then there was a comparison between the two clusters.

The effects of the lean implementation level to job demands and stress were tested for the whole sample (services and manufacturing).

The methods applied to gather data involved questionnaires, interviews and observations. The interviews were semi-structured with managers and lean officials, safety officers and workers in the sample. One manager and the lean officer were interviewed about the different components of lean production implemented in each company. Workers were interviewed about job characteristics and actual lean implementation, stressors at work, positive challenges and improvement suggestions. In the case where there was no possibility to directly interview workers, safety officers and union representatives with broad view of the working conditions and lean application in practice in the company were interviewed. In total 22 persons were interviewed in the 5 companies of the sample. Finally, observation visits in the companies completed the data collection process.

5.1.2 LEAN CLASSIFICATION MODEL

The Conti et al. (2006) model presented in Table 1 was used to assess lean implementation level in the case studies.
The lean characteristics identified in this model were set up reduction, inventory and waste reduction, kanban pull signals, supplier partnerships, continuous pmprovement program, mixed-model production /(Continuous flow – Cellular production), mistake proof (poka-yoke), total preventive maintenance and Standard Operating Procedures (SOP).

The implementation level in each case study for the above nine lean characteristics was estimated on a five-point scale, ranging from “will not implement” to “advanced implementation”. The nine values were then averaged to produce a measure of the degree of implementation in each case study.

All companies participating in the study were classified according to this system. The evidence on implementation was gathered from semi-structured management interviews and plant tours and the judgement of level of implementation was made subjectively as a result. Regarding the level of lean application, in accordance with the classification made on a five-point scale, one case had moderate implementation, three cases had a fair level (5-7 lean characteristics fairly implemented) and the case in UK had full lean application (all characteristics in advanced implementation). A table illustrating the distribution of companies in lean implementation follows. More information on the companies and their level of lean application is provided in Appendix 10 and Section 5.2.4. The mean lean implementation is 3.62.

Table 5: Levels of lean implementation in the sample

Level of lean implementation	N (companies)
Moderate: (2.5 -3)	1
Fair: (3-4)	3
Advanced >4 - 5	1

5.1.3. QUESTIONNAIRES

In order to investigate the consequences of lean systems for the above risk factors a combination of different techniques were used. The study employed validated worker questionnaires regarding psychosocial factors and MSD symptoms, management and employee interviews and plant tours. To assess ergonomic risk factors for Musculoskeletal Disorders like repetitiveness, force exertion, awkward postures and others, exposure assessment tools in combination with work activities it was initially planned to use video recording to complement the questionnaires. For practical reasons this was not feasible during the study. The companies that gave access did not allow the use of video. However, qualitative data were collected via plant tours and semi-structured "face to face" interviews to the managers, lean officials, safety officers and workers.

For the MSD pain assessment the 'Nordic Questionnaire for Musculoskeletal Disorders' (Ikka Kuorinka et al, 1987), which is supported by the Nordic Council of Ministers, was used to compare subjective symptoms across the cases studies. Although this tool is quite old it is practically the only validated method available for MSD pain assessment. The questionnaire is divided into 4 sections: general data about the employees, symptoms experienced during the last 12 months in particular parts of the body, symptoms that have prevented employees performing their job during the last 12 months, and symptoms experienced in the last 7 days. The text has been translated into English from Swedish by native English speakers, using a multiple to-and-from technique (translation from Swedish to English and then translation back to Swedish to check the translation).The translation of the English questionnaire into Greek was done by the University of Crete[2] using the same approach. The questionnaire is not meant to provide a basis for clinical diagnosis. It is used to screen for MSD disorders before undertaking further analysis of the work environment. To complete the data on MSDs, statistics from relevant medical data were requested from companies, if available. No such data were made available or given to the author.

To assess the job demands, psychosocial environment and stress the 'Nordic Questionnaire on psychosocial issues' (FIOH, Kari Lindstrom et al, 2000) was used. This questionnaire has also the support of the Nordic Council of Ministers and it is designed for the assessment of psychological, social and organizational working conditions. It includes questions related to job demands and control, role expectations, organizational culture and climate, etc. Assessment of the actual psychological state of the workers was not the intention of the researcher. The questionnaire is divided into 9 sections and 18 sub-sections. The questions for each sub-section are presented in Table 6. Questions regarding performance monitoring have been added to the original short version of the Nordic Psychosocial Questionnaire to reflect the call centre situation.

[2] Translation to Greek: Αντωνοπούλου Μ., Ekdahl C., Σγάντζος Μ., Αντωνάκης Ν. και Λιόνης Χ., Κλινική Κοινωνικής και Οικογενειακής Ιατρικής του Τμήματος Ιατρικής του Πανεπιστημίου Κρήτης

Table 6: Questionnaire section contents		
Sections and subsections	**Questions[3]**	**Number of questions**
Job demands		
Quantitative demands	que.1, que.2	2
Learning demands	que.3, que.4	2
Quantitative targets	que.36	1
Role expectations		
Role clarity	que.7, que.8	2
Role conflict	que.9	1
Control at work		
Positive challenge at work	que.5, que.6	3
Control of decisions	que.10, que.13	2
Control of work pacing	que.11, que.12	2
Predictability at work		
Predictability during the next month	que.14	1
Rumors at work	que.15	
Mastery of work		
Perception of mastery	que.16	1
Social interactions		
Support from superior	que.18, que.19	2
Support from coworkers	que.17	1
Support from friends and relatives	que.22	1

[3] Que.: Question

Empowering Leadership		
Encouragement to take decisions	que.20, que.21	2
Organisational culture		
Social climate	que.23, que.24, que.25	3
Innovative climate	que.28, que.29	2
Inequality	que.37, que 38	2
Human resource primacy	que.39, que.40	2
Social relations	que.30	1
Harassment at work[2]	que.41, que.42	2
Group work	que.26, que.27	2
Control of employees performance	que.31, que.32, que.33, que.34, que.35	5
Job satisfaction	que.43, que.44	2
Stress	que.45	1

This questionnaire was selected because it investigates all the work characteristics that can be influenced by lean production. Moreover it tests the team dynamics in an organization via group support and communication. Teams (manufacturing cells) are at the heart of lean systems.

The questionnaires in English are found in the appendixes 10.2, 10.3 and 10.4. An effort was made to introduce the questionnaires uniformly to the workers in the case studies. The questionnaires were distributed to the workers and returned sealed to ensure anonymity. Direct distribution was not possible. The questionnaires were distributed via the Human Resources Managers, Site Directors, Heads of Departments and Safety Engineers. However, there was a full presentation of the questionnaires to the officers that passed on the information. Moreover a short written introduction was included to explain the purpose and aims of the questionnaires.

This was possible in all cases with the exception of the electronics industry (located in Silicon Glen in Scotland, UK) that was at the edge of technology and rejected the distribution and responding to questionnaires via mail. The distribution and response of questionnaires was made electronically. This made anonymity impossible since the responses reached the author via emails that were personal. However, the responders replied directly to the author and not via any manager. Moreover the actual number of questionnaires distributed was outside the control of the author since they were distributed by the manager via email to the employees working in lean departments.

The basic values of the psychosocial questionnaire were compared with its normative values (Lindstrom et al, 2000) and presented in the relevant chapters of the field study.

The Statistical Package for the Social Sciences, IBM SPSS version 20.0 (IBM SPSS Inc, Chicago, IL, USA) was used to analyze data. Results were expressed as percentages and mean ± standard deviation. Comparisons between categorical variables were done with x^2 (Pearson's chi-square or Fisher's exact test). Comparisons between study groups were performed with the Mann–Whitney U test and correlations were tested by the Spearman's rank correlation coefficient, tests for non-parametric distributions. Logistic regression analysis was used to measure the influence of independent variables upon a categorical dependent variable. Linear regression analysis was performed to find a linear relationship between a continuous response variable and possible predictors. Also polynomial terms (quadratic) were applied to linear regressions in order to fit curves. Multiple regressions were used to adjust for confounding variables and isolate the relationships of interest. A p value of <0.05 was considered statistically significant.

In the aluminum and electronics company only the psychosocial questionnaire was accepted. More details on the field-work are provided in Appendix 10.5.

5.2 RESULTS

In total 353 workers responded to the questionnaires. In particular 181 psychosocial questionnaires and 236 MSD questionnaires were completed and returned. For all cases the psychosocial questionnaire had a 36.2% response rate and the MSD questionnaire a 59% response rate. Additionally qualitative data were collected through semi-structured interviews with managers and lean officials, safety officers and workers in the sample. Finally, observation visits in the companies completed the data collection process.
The Cronbach's alpha is equal to 0.8, suggesting that the items in the questionnaires have relatively high internal consistency.

5.2.1 SERVICES CLUSTER: TELECOMMUNICATION CALL CENTRES

5.2.1.1 Introduction

Call centres, are not a conventional representative of lean production systems. However, they do apply clear lean practices. Such practices are: reduction of the client' response time to the minimum, quality control, mistake proof policies and similar techniques. Moreover services tend to be the third wave of lean systems application following auto industry, electronics and manufacturing in general.

Two big telecommunication companies in Greece were approached and the methodology was presented. Managers from both companies were interviewed to evaluate the level of leanness. The following descriptions of systems in these companies come from these interviews.

The first company was the national telecommunication company where 2 call centres in Athens have been selected. In total there were 500 employees in the 2 call centres. The first call centre was the basic yellow pages service for providing catalogue information in Greece and the work was more intense, although little technical capacity was required. The operators replied to inbound calls[4].

The second call centre provided technical services and the difficulty for the employees according to them was in answering correctly. The operators in the technical services are considered salespersons because they inform about specific services, such as changing telephone lines, new connections, etc. Moreover operators could inform the client of other services not requested in the call. They could also make outbound calls to inform clients of new services. Short time contract employees are mostly employed in the first call centre and full time job employees in the second one.
The managers provided data on the lean practices applied in the two call centres that were confirmed by the call centre operators. The company had a strict policy for delivery time reduction (in lean terms - waste reduction). The average calls made by a member of staff in a shift was between 220-260 for the yellow pages call centre. Trainees had a lower average of calls per shift of 180 at first and this increased with working experience. For the technical call centre there was a minimum target of 80 calls per shift per person. No break was allowed in the shift of the yellow pages call centre. The working hours for the technical call centre were 6.5 with two 30 minutes break. Both call centres did have quality control and electronic monitoring of performance. There was high level of standardisation and dialogue scripting, identified as lean characteristics by Sprigg & Jackson (2006).

The second company was a multinational mobile phone company with 5 call centres in Athens. There were 200 employees in total with an average of 2 years contract. The duration of an average call was about 30 seconds. Standardisation and dialogue scripting was also applied with 20 standard phrases (verbal protocol).

The call centres had waste reduction practices, continuous improvement program, total quality management, continuous flow and standard operating procedures. The lean level score given to both companies after the interviews was 3.5.

[4] Inbound calls are the incoming calls from clients seeking information through the system and outbound calls are calls from the operator to the customers.

The first company accepted the whole methodology for the research that is to say both questionnaires (psychosocial and MSD symptoms). It was decided to distribute the MSD questionnaire only to the permanent employees because the employees with short time contracts had not been working long enough to develop MSD symptoms. In total 200 psychosocial and 100 MSD questionnaires were distributed to the selected call centres of the company.

The second company did not approve the psychosocial questionnaire due to internal reasons. The pretext was that a questionnaire investigating similar issues was launched few months before the field study. The actual reason was most probably that team leaders did not want to be judged on their abilities and support for call centre operators. Therefore only the MSD questionnaire was administrated. In total 200 questionnaires were allowed to be distributed.

The total response rate for the MSD questionnaire for both telecommunication companies was 70%.

In addition to the questionnaires, interviews were conducted with a number of employees in both companies (six interviews) to obtain additional qualitative data and cross check the results of the questionnaires. The employees had varied experience from 7 months to 7 years. The interviews were semi-structured and carried out face-to-face at the companies. The employees were working in the general information call centre (yellow pages) and technical information call centres. The average interview duration was 1 hour and 30 minutes. The questions were about working experience, training received, workload, stressors at work, control of performance, improvement suggestions, etc.

The next section presents the results and statistical analysis of the psychosocial questionnaire. The total results for the musculoskeletal data concerning both companies are presented in the following section. Qualitative data from the interviews and the observations are integrated in the respective sections of the reports of the results.

5.2.1.2 Psychosocial factors

The analysis of the psychosocial questionnaire data is based on a sample of 116 customer representatives in 2 call centres. The characteristics of the employees are presented in table 7. The average age of the employees is 27 years old with standard deviation of 7 years.

Table 7: Sex distribution

		Total
Sex	**Man**	31
	Woman	85
	Total	116

Descriptive data

The statistical descriptive data are presented in tables 8–33. There the average (basically mean score since we suppose that the scale from 1-5 is continuous) and the standard deviation for each question are presented. The tables are presented according to the subsections of the questionnaire in Table 6 in section 5.1.3. If for a question the mean is less than 3, this means the occurrence is less frequent compared with questions where the mean is bigger than 3.

It is observed that for the questions regarding job demands, role conflict, control of work, positive challenges at work, empowering leadership, inequality, human resource primacy, social relations, job satisfaction and stress the answers are all at the less frequent end of the scale. By contrast for the questions regarding quantitative targets, role clarity, predictability, mastery, support from co-workers and the superior, support from relatives, social climate, efficient group work and control of employee performance, the answers are at the quite frequent end of the scale.

The psychosocial environment in the call centres if we consider the Karasek model has rather low demands with low job control and high support from co-workers and superiors. Stress is not frequent but neither is job satisfaction.

All variables of the psychosocial questionnaire were compared to the corresponding normative values (Lindstrom et al., 2000). The reference/normative data of the QPSNordic questionnaire are based on results on 2015 respondents from different Nordic countries working in industrial production and services.

The job demand variables are lower and the support variables higher in the call centres compared to the normative values of the psychosocial questionnaire. However job control is lower and stress is higher in the call centres compared to the normative values.

The scores for each of the component parts of the questionnaire will now be reviewed.

Job demands

The questions relating to job demands measure time pressure and workload. The employees in the call centres reported that they did not very often experience high workload *(Table 8).* High quantitative demands are related to high levels of stress. Yellow pages operators found tiresome the continuous flow of calls and the non-stop talking. Technical services operators on the other hand experienced some times time pressure because the services were charged and the clients exerted pressure to get their answer as quickly as possible. To quote from an interview with an operator from the technical services regarding pressure '…this is a traditional shop floor, there is no time for breathing'. Although workload was reported low in the questionnaire some workers described it being high in the interviews.

The question relating to learning demands measures the level of difficulty that employees face in order to respond to their duties due to limited training. The whole sample responds well to these demands *(Table 9).* However, operators in the technical services interviewed reported higher learning demands due to the complexity of the questions of the clients and the high responsibility they carry to give good answers.

The job demands in the call centres are lower compared to the respective normative values of the psychosocial questionnaire (mean 3.29 and 2.14 for the quantitative and learning demands respectively).

Table 8: Quantitative job demands

Question	Mean	SD
Is your workload irregular so that the work piles up?	2.42	1.44
Do you have too much to do?	3.01	1.34
Composite scale score	**2.68**	**1.08**

Table 9: Learning demands

Question	Mean	SD
Are your work tasks too difficult for you?	1.71	0.92
Do you perform work tasks that you need more training?	2.12	1.20
Composite scale score	**1.93**	**0.91**

Quantitative targets were reported achievable. However technical services operators reported pressure from the managers to make sales.

Table 10: Quantitative Targets

Question	Mean	SD
Are targets set by the enterprise achievable?	3.11	1.02
Composite scale score	**3.11**	**1.02**

Role expectations

The high average for role expectations in *Table 11* suggests that employees' duties are clear and the employees know what is expected of them. This is expected as call centre operators - particularly those in the 'golden pages' information section - have a very clear view of their duties. Role clarity was higher than the normative values (mean 4.12). The employees in this sample very rarely face conflicting tasks (*Table 12)*. However, role conflict was higher compared to the normative values (mean 2.24).

Table 11: Role clarity

Question	Mean	SD
Have clear, planned goals and objectives been defined for your job?	4.35	0.95
Do you know exactly what is expected of you at work?	4.46	0.90
Composite scale score	**4.41**	**0.83**

Table 12: Role conflict

Question	Mean	SD
Do you receive incompatible requests from two or more people?	2.48	1.36
Composite scale score	**2.48**	**1.36**

Control at work

The employees in the sample have sometimes positive challenges in their work *(Table 13).* In addition employees have only rare chances to control important decisions in their work *(Table 14).* Control of work pacing is higher. Control at work values in the call centres are lower compared to the normative values of the psychosocial questionnaire (mean 2.7 and 2.99 for control of decisions and work pacing respectively).

The call centre operators in the outbound calls section (technical call centres) enjoyed more control at work compared to the employees in the yellow pages receiving in-bound calls.

Table 13: Positive challenge at work

Question	Mean	SD
Are your skills and knowledge useful in your work?	2.72	1.34
Is your work challenging in a positive way?	2.85	1.19
Composite scale score	**2.78**	**1.10**

Table 14: Control of decisions

Question	Mean	SD
Can you influence the amount of work assigned to you?	2.40	1.37
Can you influence decisions that are important for your work?	1.63	0.88
Composite scale score	**2.00**	**0.92**

Table 15: Control of work pacing

Question	Mean	SD
Can you set your own work pace?	2.53	1.41
Can you decide yourself when you are going to take a break?	3.44	1.28
Composite scale score	**2.98**	**0.99**

Predictability at work

Employees in the sample know in advance the kind of tasks they can expect for the next month *(Table 16)*. Knowing in advance the tasks, contributes to stress reduction according to the interviews with call centre operators. Predictability at work in the call centres was considerably higher compared to the normative values (3.57).

Table 16: Predictability during the next month

Question	Mean	SD
Do you know in advance what kind of tasks to expect a month from now?	4.05	1.35
Composite scale score	**4.05**	**1.35**

Rumors for changes

The employees report some rumors for changes at the call centres *(Table 17)*. This refers to rumors of not renewing temporary employment contracts.

Table 17: Rumors for changes

Question	Mean	SD
Are there rumors for changes at work?	2.59	1.22
Composite scale score	**2.59**	**1.22**

Mastery of work

The employees are rather often satisfied by their ability to solve problems at work at both call centres *(Table 18).*

Table 18: Mastery of work

Question	Mean	SD
Are you content with your ability to solve problems at work?	4.20	0.84
Composite scale score	**4.20**	**0.84**

Social interactions

There is support from the superior sometimes or often in the sample *(Table 19).* Rather frequently employees have support from their colleagues *(Table 20).* Finally the support from friends and relatives happens sometimes and not as often as the support from colleagues *(Table 21).* The support from superiors and co-workers is higher in the call centres compared to the normative values of the questionnaire (mean 3.34 and 3.80 respectively).

Table 19: Support from the superior

Question	Mean	SD
If needed can you get support and help with your work from your immediate superior?	4.15	0.90
Are your work achievements appreciated by your immediate superior?	3.12	1.23
Composite scale score	**3.66**	**0.92**

Table 20: Support from co-workers

Question	Mean	SD
If needed can you get support and help with your work from your co-workers?	4.34	0.84
Composite scale score	**4.34**	**0.84**

Table 21: Support from friends and relatives

Question	Mean	SD
Do you feel that your friends/family can be relied for support when things set tough at work?	3.53	1.49
Composite scale score	**3.53**	**1.49**

Empowering leadership

Employees rather rarely are encouraged to participate in important decisions or to develop skills *(Table 22).* Empowerment is lower in call centres compared to the normative values (mean 2.7).

Table 22: Empowering leadership

Question	Mean	SD
Does your immediate superior encourage you to participate in important decisions?	1.89	1.12
Does your immediate superior help you develop your skills?	2.33	1.18
Composite scale score	**2.13**	**1.08**

Organisational climate

The climate in the call centres is often encouraging and supportive, relaxed and comfortable. However the climate can be sometimes rigid and rule-based *(Table 23).* Some operators that were interviewed did not apply protocols as an act of resistance. Experienced workers considered having to reply to calls as a machine and not as a person as another source of stress. For young operators standardization was extremely stressful for other reasons because they could not remember the exact dialogue script.

Table 23: Social climate

Question	Mean	SD
Encouraging and supportive?	3.39	1.08
Relaxed and comfortable?	3.20	1.09
Rigid and rule-based?	2.88	1.17
Composite scale score	**3.16**	**0.60**

Employees rather rarely are encouraged to think of ways to improve work. In general the climate can be sometimes innovative *(Table 24).*

It is rather rare that employees are not treated equally according to their sex, where it happens sometimes that new employees are not treated equally with senior employees with more work experience *(Table 25).* The latter was reported in the interviws.

In call centres employees are rarely rewarded for a job well done. In general employees believe that rarely the management cares for their wellbeing *(Table 26).* As far as disturbing conflicts between colleagues it happens sometimes *(Table 27).*

Table 24: Innovative climate

Question	**Mean**	**SD**
Are workers encouraged to think of ways to do things better at your workplace?	2.47	1.08
Is there sufficient communication in your department?	3.57	1.13
Composite scale score	**3.00**	**0.88**

Table 25: Inequality

Question	**Mean**	**SD**
Have you noticed any inequalities in how men and women are treated at your workplace?	1.95	1.34
Have you noticed any inequalities in how older and younger employees are treated at your workplace?	2.85	1.36
Composite scale score	**2.40**	**1.17**

Table 26: Human resource primacy

Question	Mean	SD
At your organization are you rewarded (money, encouragement) for a job well done?	2.08	1.18
To what extend is the management of your organization interested in the health and well being of the employees?	2.80	1.16
Composite scale score	**2.44**	**0.90**

Table 27: Social relations

Question	Mean	SD
Have you noticed any disturbing conflicts between coworkers?	2.29	1.15
Composite scale score	**2.29**	**1.15**

Group work

In general employees appreciate belonging in the work group *(Table 28).*

Table 28: Group work

Question	Mean	SD
Do you appreciate belonging to your work group or team?	3.53	1.02
Is your group or team successful at problem solving?	3.65	0.92
Composite scale score	**3.60**	**0.88**

Performance monitoring

The employees' performance is controlled electronically very often *(Table 29).* Only half of employees were aware of the exact method of control *(Table 30).* The majority of the employees reported that they were not consulted about the introduction of performance control.

Sixty-five employees believed that their superiors are trained to judge their performance according to a prescribed fair way and in confidence whereas the rest do not agree.

According to the interviews performance monitoring mostly bothered the new employees who were insecure for their performance and efficiency. The experienced employees considered performance monitoring to be part of the job and took it for granted. However the majority of employees did not know the details of the control criteria and they were not consulted as the legislation for OSH requirements on visual display units (Directive 90/270/EEC) clearly stipulates. The call centre employees preferred the performance control with qualitative criteria rather than quantitative such as monitoring calls by call centre supervisors. Employees disagreed with the presentation of achievements of performance targets by each employee each month and preferred the presentation of group results. In the private company the walls were hung with monthly operator's performance tables. In the technical call centres performance control was not an issue since operators were assigned to different projects that were not comparable. Performance monitoring was not stressful since the projects different employees run are not comparable.

Employees are stressed on the reaction of the client to the outbound calls. Moreover if there is a tight deadline for a project then there is a specific number of calls.

Table 29: Control of employees' performance

Question	Mean	SD
Is your performance controlled electronically?	4.42	0.95
Composite scale score	**4.42**	**0.95**

Table 30: Information – consultation for performance monitoring

	Yes	No
Have you been informed about the way that your performance is controlled?	56 (51%)	54 (49%)
Were you consulted for the introduction of the performance control?	4 (4%)	106 (96%)
Have your comments been considered?	7 (7%)	95 (93%)
Are your immediate superiors trained to judge your performance according to a prescribed fair way and in confidence?	66 (65%)	36 (35%)

Job satisfaction

Employees in the call centres are some times satisfied by their work *(Table 31).* Call centre operators felt satisfied when they had replied to a difficult question of the client. Job satisfaction is higher in call centres compared to the normative values (2.6).

Table 31: Job satisfaction

Question	**Mean**	**SD**
I like to be absorbed in my job most of the time	2.86	1.29
The major satisfaction in my life comes from my job	2.59	1.22
Composite scale score	**2.71**	**1.03**

Stress

Quantitative job demands, learning demands, role expectations, control of work rhythm, workload predictability, support from co-workers, climate in the work group and employees reward are the factors that influence the presence or not of stress at work as it is presented in *Table 32*. Stress is higher in call centres compared to the respective normative values (2.4).

Table 32: Stress

Question	Mean	SD
Do you feel stress these days?	2.74	1.39
Composite scale score	**2.74**	**1.39**

A table *(Table 33)* follows with the distribution of percentages for the different questionnaire sections in all 5 scales for the call centres (Very seldom or never, rather seldom, sometimes, rather often, very often). The distribution percentages are also presented for a reduced scale of 3 (merged scale 1 with 2, 3 and merged scale 4 with 5).

Table 33: Percentage distributions of items of the QPSNordic 34+

	Percentage distribution of items					Reduced scale percentage distribution of items		
#	1 %	2 %	3 %	4 %	5 %	1&2 %	3 %	4&5 %
Que 1	42	13	18	16	11	55	18	27
Que 2	19	14	32	18	17	33	32	35
Que 3	53	31	10	5	1	84	10	6
Que 4	45	13	29	9	4	58	29	13
Que 5	21	28	22	14	14	49	22	28
Que 6	16	21	35	19	10	37	35	29
Que 7	1	5	12	20	61	6	12	81
Que 8	2	3	9	21	65	5	9	86
Que 9	33	19	24	12	11	52	24	23
Que 10	41	11	21	21	7	52	21	28
Que 11	31	24	22	7	16	55	22	23
Que 12	9	16	24	25	27	25	24	52
Que 13	57	30	8	5	1	87	8	6
Que 14	11	6	6	24	54	17	6	78
Que 15	22	28	27	15	8	50	27	23
Que 16	2	-	16	41	41	2	16	82
Que 17	1	3	11	33	53	4	11	86
Que 18	1	3	21	32	44	4	21	76
Que 19	12	17	31	24	15	29	31	39
Que 20	50	27	13	7	4	77	13	11
Que 21	32	25	26	12	5	57	26	17
Que 22	17	9	15	21	38	26	15	59
Que 23	5	17	29	34	16	19	29	50
Que 24	7	18	39	22	14	25	18	36
Que 25	15	21	34	22	9	36	34	31

Que 26	4	8	36	34	18	12	36	35
Que 27	2	9	28	46	16	11	28	62
Que 28	23	30	27	20	1	53	27	21
Que 29	4	17	22	35	23	21	22	58
Que 30	31	30	24	11	5	61	24	16
Que 31	4	1	8	25	63	5	8	88
Que 36[5]	9	14	38	34	5	23	38	39
Que 37	59	10	17	5	9	69	17	14
Que 38	21	21	25	17	16	42	25	33
Que 39	46	16	27	8	4	62	27	12
Que 40	17	21	31	25	6	38	31	31
Que 43	20	23	15	35	7	43	15	42
Que 44	24	30	12	33	2	54	12	35
Que 45	27	20	19	22	13	47	19	35

[5] Here there is a jump between question 31 to question 36 because questions 32-35 refer to performance monitoring and are categorical.

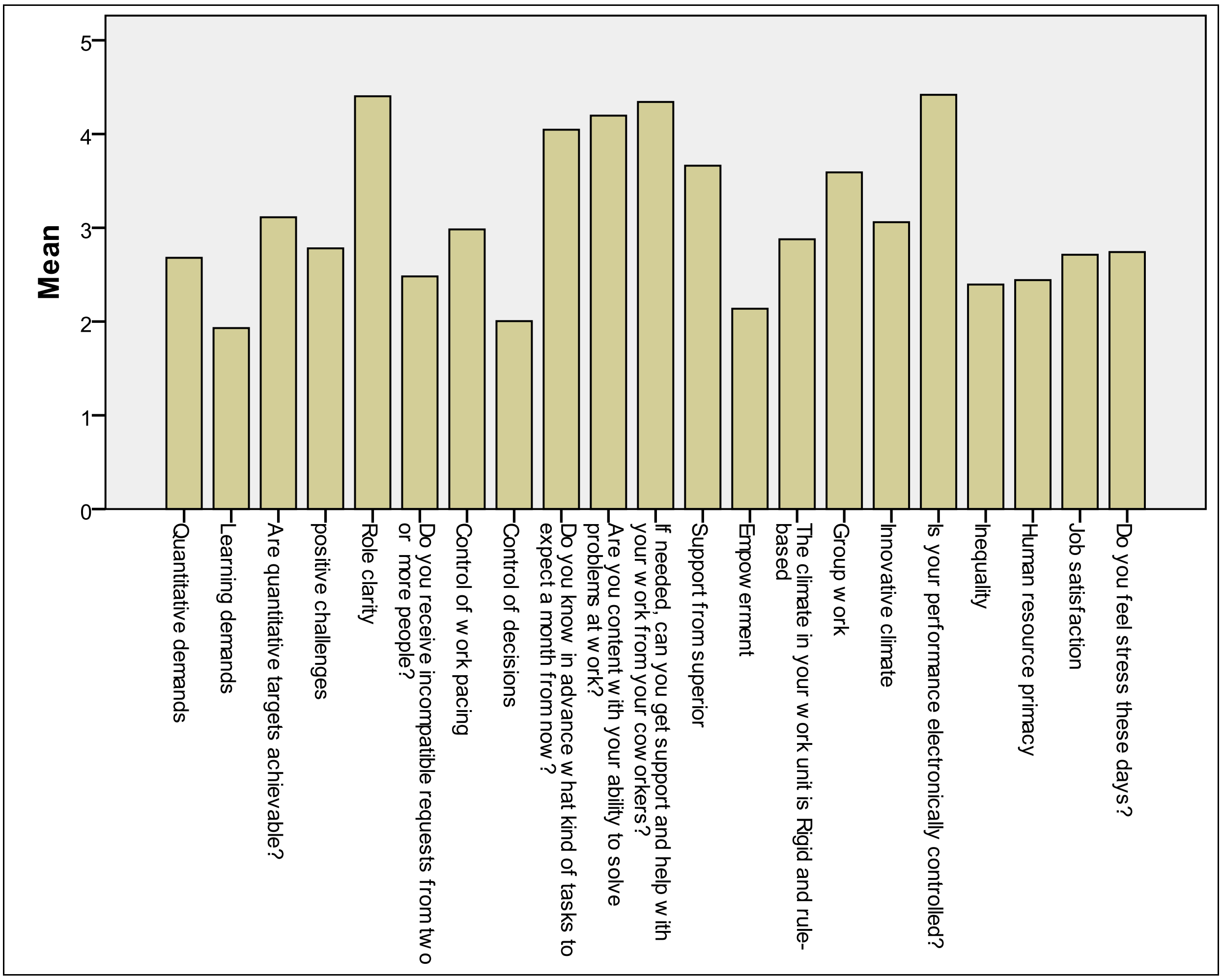


Diagram 1: Mean values of psychosocial factors in call centres

Correlations

The correlations between the sub-sections and the satisfaction from work and Job stress are presented in *Table 34*.

It was found that:

The stress is increasing the more frequent were the following characteristics:

- Quantitative job demands
- Learning demands
- Role clarity /Role conflict
- Disturbing conflicts
- Electronic performance monitoring
- Rumors for changes at work

The stress is diminishing the more frequent were the following characteristics:

- Control of work pacing
- Predictability during the next month
- Support from coworkers
- Positive Social climate
- Innovative climate
- Efficient group work

The satisfaction from the job in certain employees was increasing the more frequent were the following characteristics:

- Role clarity
- Positive challenges at work
- Control of decisions
- Support from superior
- Empowering leadership
- Efficient group work
- Innovative climate
- Human resources primacy

Table 34: Correlations between subsections

Sections and subsections	Job satisfaction		Stress	
Job demands	Correlation coefficient	*p*-value	Correlation coefficient	*p*-value
Quantitative demands	-0.042	0.578	0.295	0.002**
Learning demands	0.080	0.289	0.375	0.000**
Target achieving	0.129	0.104	0.016	0.879
Role expectations				
Role clarity	0.151	0.046*	0.205	0.032*
Role conflict	0.070	0.366	0.327	0.001**
Control at work				
Positive challenge at work	0.455	0.000**	0.103	0.278
Control of decisions	0.360	0.000**	0.043	0.658
Control of work pacing	0.080	0.289	-0.304	0.001**
Predictability at work				
Predictability during the next month	-0.118	0.122	-0.307	0.001**
Mastery of work				
Perception of mastery	0.011	0.892	-0.024	0.810
Social interactions				
Support from superior	0.285	0.000**	-0.047	0.626
Support from coworkers	-0.059	0.439	-0.216	0.022*
Support from friends and relatives	-0.053	0.494	-0.09	0.927
Empowering Leadership				
Encouragement to take decisions	0.417	0.000**	0.008	0.936
Organisational culture				
Social climate	-0.037	0.631	-0.232	0.014*
Innovative climate	0.308	0.000**	-0.224	0.020*
Inequality	-0.037	0.696	-0.005	0.954

Human resource primacy	0.256	0.007**	-0.025	0.798
Social relations	-0.142	0.062	0.279	0.003**
Rumors for changes at work			0.327	0.01**
Group work	0.198	0.009**	-0.229	0.017*
Control of employees performance	0.127	0.122	0.189	0.049*

**Correlation is significant at 0.01 level

*Correlation is significant at 0.05 level

Statistical controls

The non-parametric control (Mann-Whitney U test) of the other performance control variables showed no statistically significant variable influencing stress.

The effect of electronic monitoring in the level of satisfaction is presented in *Table 35*. It was found that the employees that have been consulted in the introduction of the monitoring system and their comments were taken into account had a higher job satisfaction level.

Table 35: Job satisfaction and control of performance			
Job satisfaction			
Comments taken into account	**Mean**	**SD**	***p* value**
Yes	3.57	0.78	0.021
No	2.66	1.00	0.021

Explanatory models

Stress

An attempt was made to model stress as a dependent variable with the explanatory variables being the quantitative and learning demands, role conflict, control of work pacing, support from co-workers, social climate, innovative climate, predictability, group work, performance monitoring and consultation during performance monitoring.

The stepwise regression for job stress in the services cluster is presented in *Table 36*. There is no evidence of collinearity, with all VIF values below 1.5. Job stress in call centres is satisfactorily explained by quantitative and learning demands at work and rumors for changes at work that have a positive relation and control of work pacing that has a negative one. The model F is 8.5 (df=95), p=0.000 and R Square =27.2% and adjusted R Square =24.0%.

The hypothesis 1 that job stress is positively related to quantitative job demands in lean establishments is supported. This was also reported in the interviews. Also visual management techniques, typical in lean environments, were found to be present in call centres. An example was neon notification signs informing operators about the number of calls that were waiting for answer that was extremely stressful for operators. Also learning demands were found to explain stress. Indeed the complexity of problems in technical services was stressful since this service was the highest level of training an operator could acquire.

The hypothesis 2 that job stress is positively related to performance monitoring is not supported. Although electronic monitoring has an initial positive correlation with stress it is not significant in the explanatory model and therefore excluded. According to the interviews what was more stressful was not the electronic monitoring of performance as such but the ignorance of the exact quality criteria it was based on.

The hypothesis 3 that job stress is negatively related to job control in lean establishments is partly supported for control of work pacing. Indeed according to the interviews especially as regards outbound calls where there was some control of work pacing, employees were less stressed at work. By contrast operators receiving inbound calls all the time were stressed by the lack of control they had over their work pace.

Table 36: Explanatory model for Stress

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	1.675	.299		5.599	.000	1.081	2.268		
	Learning demands	.515	.140	.354	3.667	.000	.236	.794	1.000	1.000
2	(Constant)	2.785	.481		5.784	.000	1.829	3.741		
	Learning demands	.531	.135	.365	3.924	.000	.262	.800	.998	1.002
		-.367	.127	-.268	-2.878	.005	-.620	-.114	.998	1.002
3	(Constant)	2.467	.491		5.025	.000	1.492	3.442		
	Learning demands	.438	.139	.301	3.156	.002	.162	.713	.911	1.098
	Control of work pacing	-.408	.126	-.298	-3.238	.002	-.658	-.158	.978	1.022
	Rumours for changes at work	.244	.107	.220	2.284	.025	.032	.456	.892	1.121
4	(Constant)	2.002	.535		3.740	,000	,939	3.066		
	Learning demands	.339	.145	.233	2.342	,021	,052	.627	.807	1.239
	Control of work pacing	-.405	.124	-.296	-3.269	,002	-,651	-.159	.978	1.023
	Rumours for changes at work	.230	.105	.207	2.185	,031	,021	.440	.888	1.126
	Quantitative demands	.253	.125	.194	2.014	.047	.003	.502	.862	1.160

Job satisfaction

An effort was made to model job satisfaction as the dependent variable with the explanatory variables being the positive challenges at work, control of decisions, support from superiors, empowerment, human resource primacy and employees' comments take into account for performance monitoring.

The stepwise regression for job satisfaction is presented in *Table 37*. There is no evidence of collinearity, with all VIF values below 1.5. Job satisfaction in call centres is partly explained by positive challenges at work and control of decisions. The model *F* is 9.487 (df=94), *p*=0.000 and R Square =17.1% and adjusted R Square =15.3%.

Table 37: Explanatory model for Job satisfaction

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	1.825	.256		7.122	.000	1.316	2.334		
	Positive challenges	.317	.087	.353	3.643	.000	.144	.490	1.000	1.000
2	(Constant)	1.515	.286		5.295	.000	.946	2.083		
	Positive challenges	.251	.090	.280	2.789	.006	.072	.430	.895	1.117
	Control of decisions	.243	.107	.227	2.261	.026	.030	.456	.895	1.117

This is also confirmed by the interviews where employees felt satisfaction from their job when they replied to difficult questions of the clients.

5.2.1.3 Musculoskeletal disorders

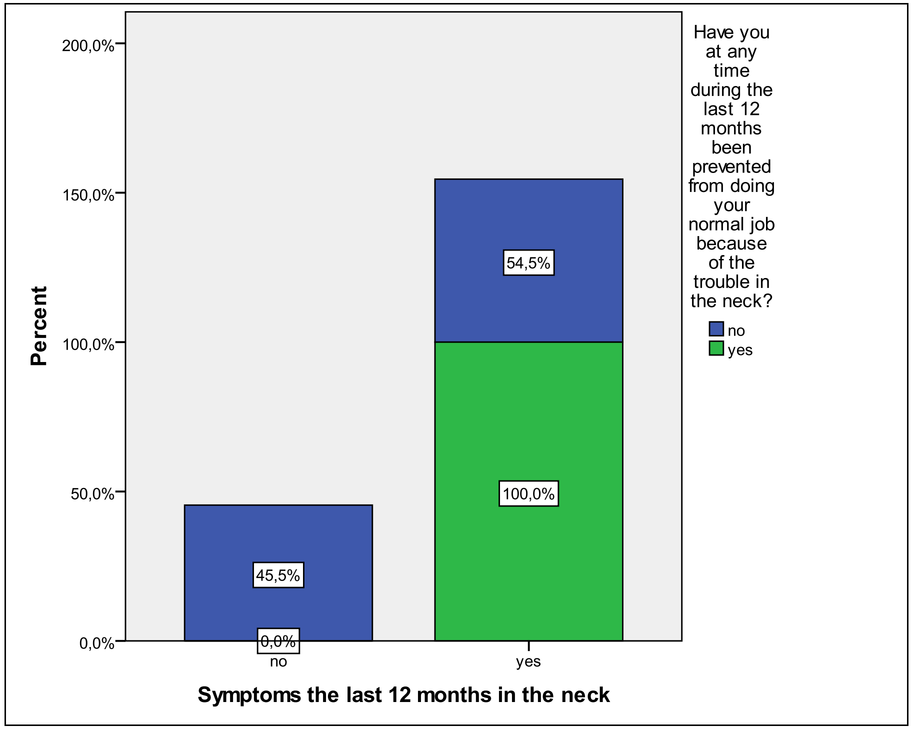
Introduction

The questionnaire for musculoskeletal disorders was distributed to 300 employees in the call centers of the two telecommunication companies of which 210 employees responded. The sampling within samples was random.

From the reports of symptoms (ache, pain, discomfort) in the last 12 months in the musculoskeletal system, employees in the call centers seem to suffer mostly from symptoms in the neck (58%), shoulders (50.7%), wrists/hands (46.6%), lower back (34%), knees (25.6%) and upper back (23%). The results are presented in detail in *Table 38*.

In *Table 39* the results that concern symptoms that employees reported in the last 12 months that prevented them from completing their work are presented. In *Table 40* the last 7 days symptoms' frequencies are presented.

It was found that of the 107 employees that reported symptoms in the neck in the last 12 months (and replied to the relevant to the symptoms questions), 44 could not complete their work due to these symptoms and 62 had symptoms in the last 7 days. Respectively from 84 employees that reported symptoms in their shoulder the last 12 months, 30 could not complete their work due to these symptoms and 54 had symptoms in the last 7 days.



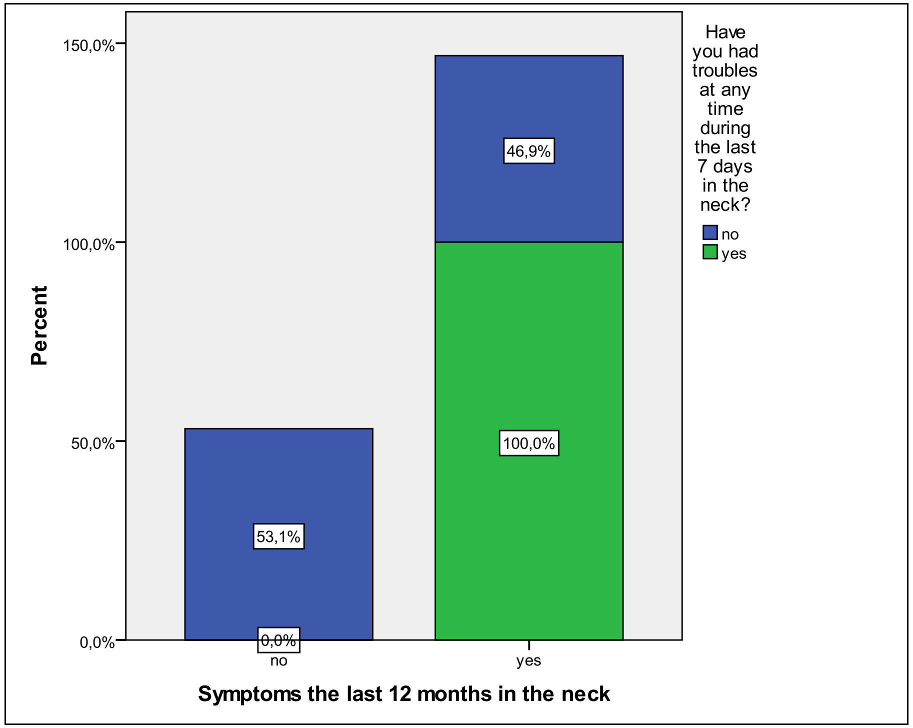


Diagram 2: Employees with symptoms the last 12 months in the neck being prevented from work

Diagram 3: Employees with symptoms the last 12 months in the neck that had troubles the last 7 days

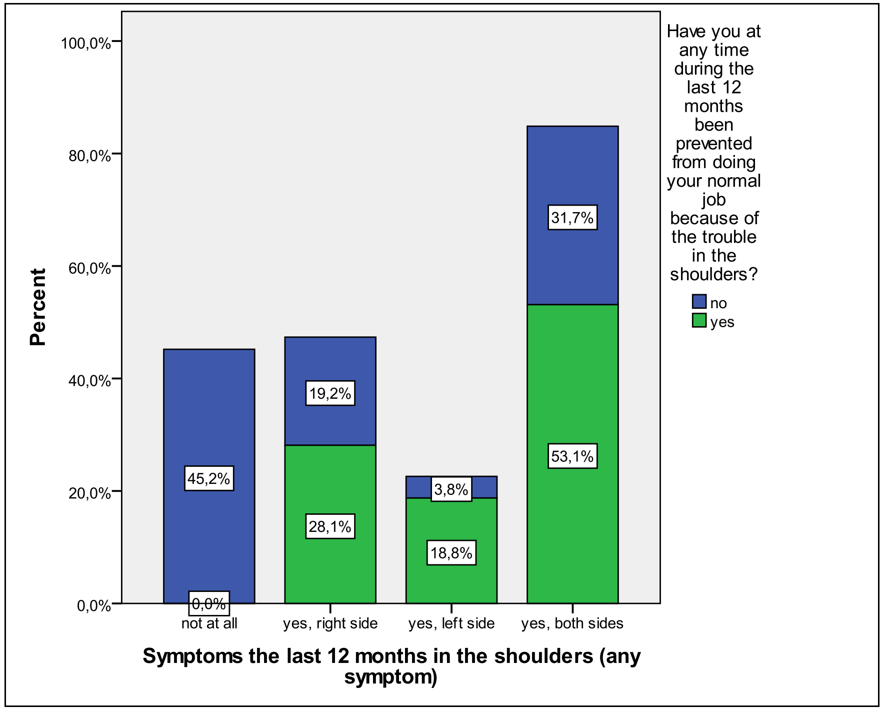


Diagram 4: Employees with symptoms the last 12 months in the shoulders being prevented from work

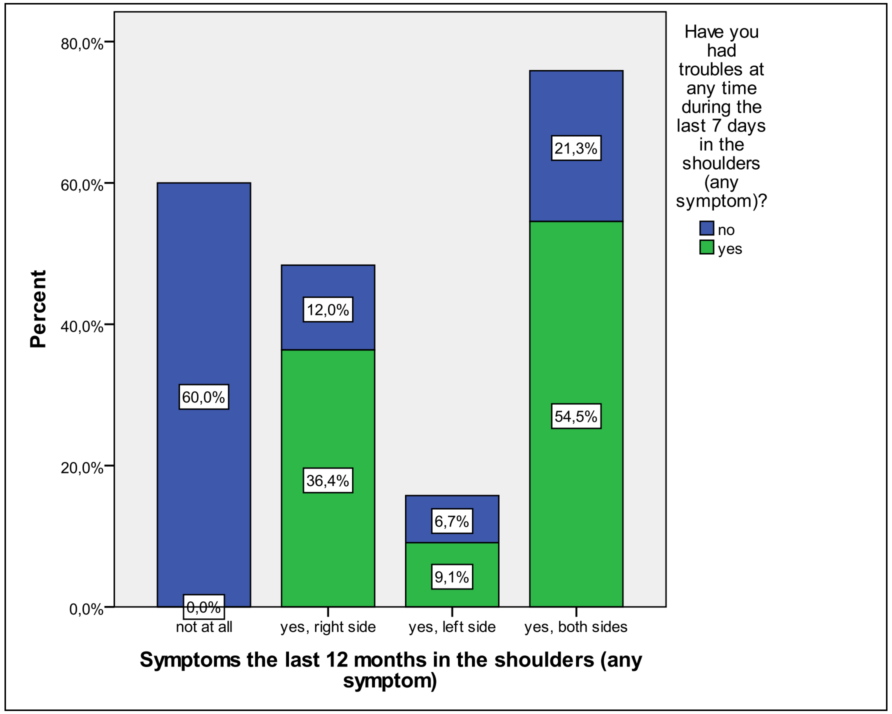


Diagram 5: Employees with symptoms the last 12 months in the shoulders that had troubles the last 7 days

Table 38: Symptoms the last 12 months in:			
		Frequency	**Percentage %**
Neck	No	85	42.1
	Yes	117	57.9
Shoulder	No	92	49.2
	Yes in right shoulder	32	17.1
	Yes in left shoulder	10	5.3
	Yes in both shoulders	53	28.3
Elbows	No	160	87.0
	Yes, in right elbow	15	8.2
	Yes in left elbow	4	2.2
	Yes in both elbows	5	2.7
Wrists/hands	No	102	53.4
	Yes, in the right wrist/hand	60	31.4
	Yes, in the left wrist/hand	5	2.6
	Yes, in the both wrists/hands	24	12.6
Upper back	No	151	77
	Yes	45	23.0
Lower back	No	131	66.2
	Yes	67	33.8
One or both hips	No	169	85.8
	Yes	28	14.2
One or both knees	No	145	74.4
	Yes	50	25.6
One or both ankles/feet	No	175	88.8
	Yes	22	11.2

Table 39: Have you at any time during the last 12 months been prevented from doing your normal job because of the trouble?			
		Frequency	**Percentage %**
Neck	No	122	73.5
	Yes	44	26.5
Shoulder	No	113	76.4
	Yes	35	23.6
Elbows	No	105	91.3
	Yes	10	8.7
Wrists/hands	No	97	68.3
	Yes	45	31.7
Upper back	No	106	87.6
	Yes	15	12.4
Lower back	No	99	75.0
	Yes	33	25.0
One or both hips	No	105	90.5
	Yes	11	9.5
One or both knees	No	103	84.4
	Yes	19	15.6
One or both ankles/feet	No	108	95,6
	Yes	5	4,4

Table 40: Have you had troubles at any time during the last 7 days?			
		Frequencies	**Percentage %**
Neck	No	96	60.4
	Yes	63	39.6
Shoulder	No	85	60.3
	Yes	56	39.7
Elbows	No	101	89.4
	Yes	12	10.6
Wrists/Hands	No	87	61.7
	Yes	54	38.3
Upper back	No	95	79.8
	Yes	24	20.2
Lower Back	No	91	70.0
	Yes	39	30.0
One or both hips	No	103	90.4
	Yes	11	9.6
One or both knees	No	103	84.4
	Yes	19	15.6
One or both ankles/feet	No	100	87.7
	Yes	14	12.3

Statistical controls

A statistical comparison was made for stress and MSD symptoms. The control was made using the sample of employees that replied to the psychosocial and MSD questionnaires. The persons that reported pain in the neck and shoulders reported statistically significant higher levels of stress.

Table 41: MSD symptoms and stress

Variable		Mean	SD	*p*
Pain in the neck the last 7 days	No	2.93	1.361	0.009
	Yes	4.43	0.535	0.009
Pain in the shoulders during the last 12 months	No	2.88	1.424	0.028
	Yes	4.00	0.894	0.028
Pain in the shoulders the last 7 days	No	3.00	1.365	0.028
	Yes	4.33	0.816	0.028

Statistical controls for differentiation of the work characteristics and MSD symptoms were made. The non-parametric Man Whitney U test showed statistically significant differences between quantitative demands and pains in lower and upper back. Employees that report pain in the lower and upper back have higher quantitative demands compared to the ones that do not report pain.

Table 42: MSD symptoms and quantitative demands

Variable		Mean	SD	*p*
Pain in the upper back during the last 12 months that prevented you from doing your normal job	No	2.85	0.99	0.032
	Yes	4.75	0.35	0.032
Pain in the lower back the last 12 months	No	2.74	1.06	0.043
	Yes	3.41	0.95	0.043

The non-parametric Man Whitney U test showed statistically significant differences between control of work pacing and pain in the neck the last 7 days. Employees that reported pain in the neck in the last 7 days have lower control of work pacing compared to the ones that did not report pain.

Table 43: MSD symptoms and control of work pacing

Variable		Mean	SD	*p*
Pain in the neck the last 7 days	No	3.20	0.99	0.035
	Yes	2.47	0.72	0.035

No statistically significant differences were found for learning demands, role conflict and control of decisions.

A comparison (chi square test) was also made for performance monitoring and the MSD symptoms. A significant percentage of the persons that were not consulted for the performance monitoring methods at their work reported pain in the shoulders the last 12 months. Persons that reported their comments during consultation were not taken into account reported more pain in the elbows the last 12 months and the last 7 days.

Table 44: Pain in the shoulders the last 12 months

Consultation for the method of the performance monitoring	No	Yes	**Total**
Yes	0 (0%)	3 (100%)	**4 (100%)**
No	23 (74.2%)	8 (25.8%)	**31 (100%)**
Total	**23 (67.6%)**	**11 (32.4%)**	**34 (100%)**
p-value = 0.028			

Table 45: Pain in the elbows the last 12 months			
Comments taken into account during consultation	No	Yes	**Total**
Yes	2 (50%)	2 (50%)	**4 (100%)**
No	32 (100%)	0 (0%)	**32 (100%)**
Total	**34 (94.4%)**	**2 (5.6%)**	**34 (100%)**
p-value = 0.010			

Table 46: Pain in the elbows the last 7 days			
Comments taken into account during consultation	No	Yes	**Total**
Yes	2 (50%)	2 (50%)	**4 (100%)**
No	32 (100%)	0 (0%)	**32 (100%)**
Total	**34 (94.4%)**	**2 (5.6%)**	**34 (100%)**
p-value = 0.010			

Explanatory models for MSD symptoms

A logistic regression was made with the dependent variables being the MSD symptoms and the explanatory variables being the work characteristics that showed significant difference. The pain in the neck in the last 7 days was tested as dependent variable with the explanatory variables being the stress and control of work pacing. It was found that the pain was tripled (3.4 times) at every unit increase in stress level (*p*=0.025).

Table 47: Pain in the neck the last 7 days

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	Stress	1,216	,543	5,004	1	,025	3,372	1,162	9,782
	Constant	-6,041	2,345	6,635	1	,010	,002		

Pain in the shoulders in the last 12 months was tested as a dependent variable with explanatory variables being the stress and consultation during performance monitoring. It was found that the pain was doubled (2.1 times) at every unit increase in stress level (*p*=0.011).

Table 48: Pain in the shoulders the last 12 months

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	Stress	,720	,337	4,552	1	,033	2,054	1,060	3,978
	Constant	-3,323	1,312	6,414	1	,011	,036		

Quantitative demands were tested as explanatory variables for pain in the lower and upper back and were not found significant.

5.2.1.4 Discussion for services cluster

The research hypotheses were partly supported in call centres (*Table 49*). Quantitative demands (Hypothesis 1) are predictors of job stress (*p=0.047)*. This finding is consistent with earlier research in the sector (Sprigg & Jackson, 2006). Operators suggested that the employees in telecommunication local stores should be trained to provide more technical than basic information so as to relieve the technical services call centre operators from unnecessary workload. Also learning demands were predictors of stress (*p=0.021)*. Operators had requested training upgrading.

Performance monitoring was identified in the study by Sprigg & Jackson (2006) as a significant predictor of job stress. This is not the case in this study where Hypothesis 2 was rejected. However operators interviewed particularly the experienced ones would have preferred performance control with qualitative data (team leaders listening in to real time calls) compared to quantitative control methods. That way the difficulty of dealing with a complicated request from a client could be acknowledged.

Control of work pacing was associated with lower levels of stress. Hypothesis 3 was partly supported since control of decisions and positive challenges were not significant. This is partly consistent with the above-mentioned Sprigg & Jackson study that found complete mediation of the effect of timing control and method control in call centres.

Stress in call centres is also explained by rumors of changes at the workplace. This is consistent with studies on rumors of restructuring in the company and effects on stress (Bordia et al., 2006).

The psychosocial questionnaire also measured job satisfaction that is partly explained by positive challenges at work and control of decisions.

Hypothesis 6 -that quantitative demands are associated to MSD development- was rejected. This is not consistent with Brenner et al. (2004) study on positive relationship of MSDs with JIT practices that are associated with time pressure. However

Brenner used as a measure the actual MSD rates in manufacturing and non manufacturing establishments and in this study this was not possible. The findings are based on a self-reported symptoms questionnaire. An earlier study (Adler, Goldoftas and Levine, 1997) reported that in the first month of lean production in the automotive industry back pain cases increased 7 times. Site visits in the call centres confirmed the risk factors for MSD development. Call centre work is sedentary with static and constrained postures. There is no possibility of a break throughout the shift (for the first company not even for operators' basic needs). Hypothesis 7 is not supported since electronic monitoring was excluded from the logistic regression model as non-significant.

Stress is a predictor for pain in the neck in the last 7 days and pain in the shoulders in the last 12 months. Therefore Hypothesis 8 is supported. This is in agreement with relevant literature on psychosocial effects to MSDs (Hannan et al., 2005, Knardahl, 2000).

Table 49: Summary of findings in call centres

Hypothesis 1:	Supported/ Quantitative demands are predictors of job stress in lean call centres
Hypothesis 2:	Rejected/ Performance monitoring in lean call centres is not significant for predicting stress
Hypothesis 3:	Partly supported/ Job stress is associated with lower control of work pacing in lean call centres
Hypothesis 6:	Rejected/ Quantitative demands were not predictors of MSDs in lean call centres
Hypothesis 7:	Rejected/ Performance monitoring is not predictor of any of the MSD symptoms
Hypothesis 8:	Supported/ Stress is predictor of MSD symptoms in call centres

The interaction model of lean characteristics, effects on stress, MSDs and positive outcomes presented in section 4.3 will be examined in call centres (Figure 6).

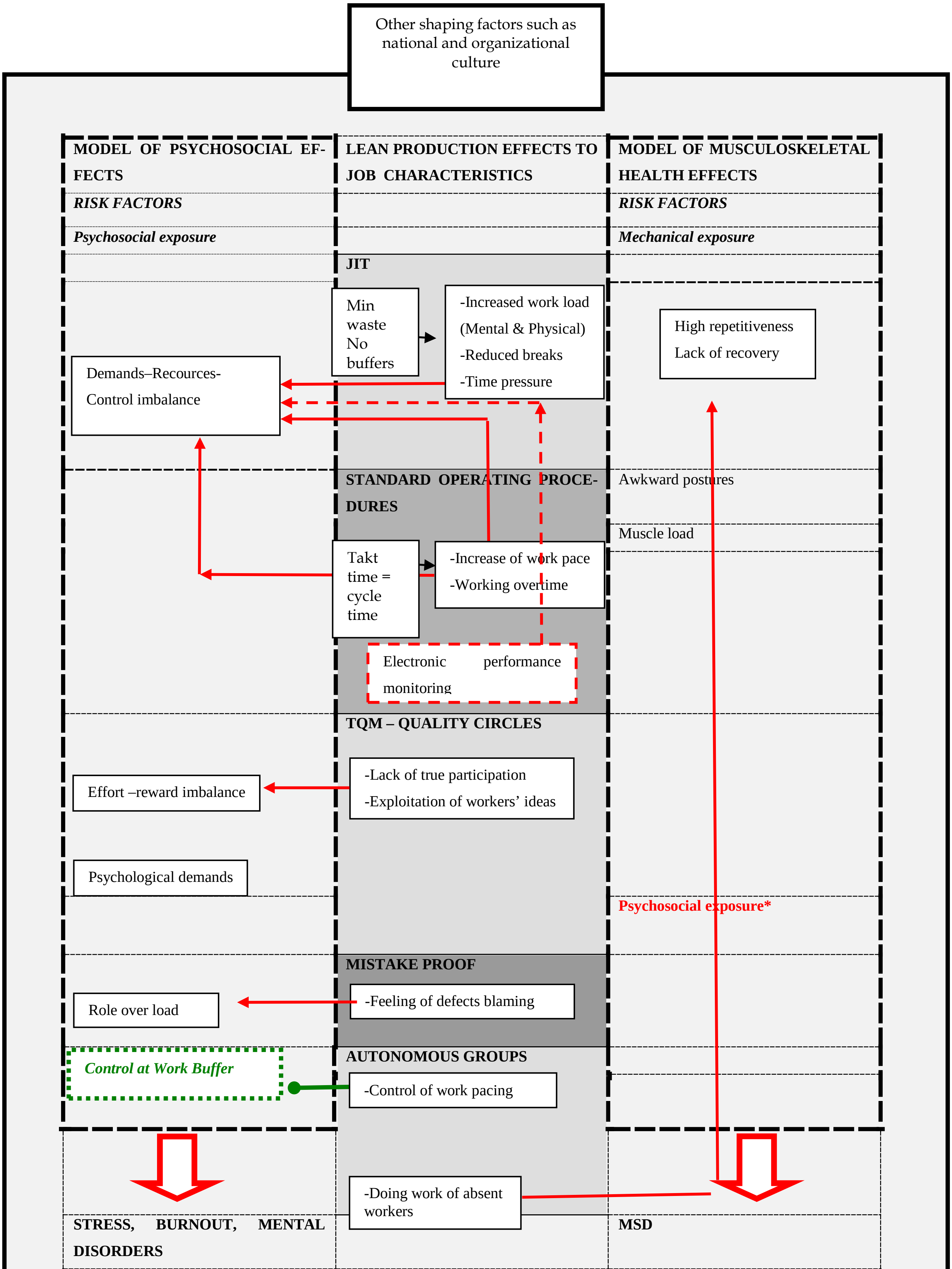


Figure 6: Application of the interaction model to call centres

The significant relations will be illustrated and the non significant relations will be omitted. Time pressure is a psychosocial stressor. High cycle time and reduced breaks are also valid. Feeling of defects blaming is represented here by mistakes and complaints by customers. Electronic monitoring, although not statistically significant as a stress predictor in this case, was added as a stressor in the model based on the evidence from qualitative data. Smith (1992) in a study in telecommunications showed that monitored employees reported higher levels of pressure than those not monitored. Therefore the pathway here is that performance monitoring leads to time pressure and therefore to a job demands/resources imbalance.

Psychosocial effects to MSD development was proved significant. Manual handling is rare in call centres. However other physical risk factors are present. There is an effort /reward imbalance since human resource primacy was low. Control of work pacing is the only buffer to stress.

In conclusion the research hypotheses are partly supported in the call centres (3 out of 6). Quantitative demands are predictors of job stress in consistency with similar studies. Stress is strongly associated with MSD development. Unexpectedly performance monitoring was not significant for explaining stress although qualitative data and a relevant study in call centres reported differently. Control of work pacing is a mediator of job stress. The interaction model between lean characteristics and effects on stress and MSDs is fairly applicable with the addition of electronic performance monitoring as a lean characteristic.

5.2.2 Manufacturing Cluster: Beverage, Metal and Electronics Industries

5.2.2.1 Introduction

Lean production as mentioned in the literature review was initially implemented in the automotive industry and later in other manufacturing sectors. For this research three companies from manufacturing sectors, namely beverage, metal and electronics from Greece and UK were clustered to form one group.

The first company is one of the largest multinational beverage companies. The plant is located in Athens, Greece. The production manager and the lean officer of the company were interviewed for the lean practices applied. The company did have some lean characteristics such as set up reduction and standard operating procedures. Furthermore continuous improvement programs were in place where frequent meetings with teams, including workers take place in order to discuss improvement suggestions. The company is certified with ISO 9000, ISO 14000, ISO 18000. The company had limited preventive maintenance and waste reduction practices. The total lean implementation was moderate and the score given to the company was 2.4 in a five-point scale. The details of the lean scoring are at the appendix 10.5.

A follow up study, a couple of years after the field study, was possible in this company where the company had more advanced lean implementation. Qualitative data were collected since distribution of questionnaires in the new situation was not accepted. The new lean manager, the safety officer and production worker of the plant were interviewed for the new lean practices implemented. In particular the company had managed to reduce further the time for cleaning the machines when changing from one product to another, which is a critical and frequent process in beverage industry. Single Minute exchange of Die (SMED) was applied. There has been a significant reduction of changeover time for example from 270 minutes to 167 minutes and from 480 minutes to 270 minutes. The change is to bottles of different volume. The calculation of the set up time is from the last bottle to the time that the new bottle catches its full speed. There was also more inventory control and buffer reduction. The maximum inventory allowed was for 15 days. Also movement waste was minimized applying 5S. Everything was in place and unnecessary movements were allegedly avoided. For example heavy dies were put on trolleys to avoid loading. The company ran effectively recognition program for improvement ideas. The program was based on a point system. Each idea gets a point that equals a Euro. Depending on whether the idea was applicable or voted as best idea it would get more points. Seventy per sent of the ideas were coming from the shop floor, twenty five from foreman and five per cent from head of departments. An example of such an idea was on a loading machine that operated in high temperatures. The electronic part of the machine was inside and was off service quite often due to the high temperature. It was suggested to locate the electronic part outside the machine. According to the lean coordinator workers were not obliged to submit improvement ideas to the management so they didn’t feel stressed about it. On the contrary they are very motivated. In addition there was a general recording and control of delays based on the system line efficiency. Finally they applied a balanced maintenance program between preventive and reactive maintenance (after breaks) after a cost-benefit analysis. Autonomous maintenance was applied. All operators were acting as maintenance workers applying standardised procedures. They received training on maintenance. Workers according to the interviewee were not opposed to the idea since taking over also maintenance tasks made them capable to deal efficiently with troubleshooting in their machines. Mistake proofing was improved to a structured problem solving procedure. After the shift the workers have a short meeting for recognising mistakes encountered and suggesting potential solutions. The daily results of all the factories are collected weekly and discussed. The results are communicated to all factories. Solutions were suggested and applied after prioritising. There is continuous evaluation of suppliers. Moreover direct contact is possible between operators with suppliers for problems. The company was certified by the mother company as lean manufacturing industry. The lean implementation level was progressed to advanced (4) compared to moderate (2.4) that was initially. The implications of advanced lean implementation and the success factors without consequences to health and safety were discussed with the lean coordinator and the safety officer of the beverage company that will be reported in the discussion section.

The second company was from the metal sector and produces aluminum profiles. The production manager and the lean officer were interviewed for determining the lean practices implemented. Fifty per cent (50%) of the production is tailor made aluminum profiles for special clients and the rest batch production profiles for retail. The plant is located in Northern Greece. The company applied fair lean production with a total lean score of 3.6 in a five-point scale. All machines had “quick changes” fixtures and the ‘set up time’ was timed every time. This was a crucial factor since the products vary very much and they do have frequent machine set-ups. There was an annual forecast based on clients’ demands. There was an effort to reduce inventory, given the fact that there was a large variety of metal profiles, although there is always some “safety inventory”. They did have a strict policy for suppliers. They had contracts with severe penalties for delays or quality problems. There were no frequent meetings with quality teams for time saving purposes. Ad hoc groups were formed when problems do arise. The company was certified with ISO 9000, ISO 14000, BS 8800. Regarding mistake proofing they did have a very strict policy against non-conformities in production that was constantly improving. The tolerance was 1%. They applied a total preventive maintenance program. For some crucial machines such as presses the maintenance was every week. They also had a checklist to detect early problems. In maintenance groups, workers from the production also participated.

The third company is a multinational in electronics sector located in Scotland, UK. It manufactures Data Centres and Customer ready systems. Ninety three per cent of the systems that the company sells are outsourced in Asia and USA. Only five per cent is built in Scotland. In total in the factory there were 500 people in production and administration. Two hundred fifty people were in assembling and testing departments. The questionnaires were distributed to the production workers. The lean manager and the production manager were interviewed for the lean implementation in the company. All the lean characteristics had high degree of implementation. Therefore the company had advanced lean implementation and the estimated lean score, was the maximum, 5. What was made clear from the beginning from the lean manager was that the company had a strict policy communicated to all the workers that there would be no layoffs due to lean implementation.

Administration of questionnaires procedure was controlled by the management in the manufacturing cluster. Only a limited number of psychocosial questionnaires (100) were allowed to be distributed in the metal and electronics company. In the beverage company 100 psychosocial and MSD questionnaires (the actual number of workers) were distributed. From the manufacturing sector 65 replied and returned the psycho-social questionnaire with a response rate of 22%. Twenty six replied to the MSD questionnaire (26% response rate). An effort was made to fill the gap of the low response rate with qualitative data from the interviews.

5.2.2.2 Psychosocial factors

The sample for the psychocosocial questionnaire in the manufacturing cluster was 65 employees with mean age 34 years old and mean years of working experience 11 years.

Descriptive data

The demographics of the manufacturing cluster are presented below:

Table 50: Sex distribution

Sex	**Man**	45
	Woman	3
	Unknown	17
	Total	**65**

Table 51: Age

Mean	34.21
SD	7.24

Table 52: Years of experience

Mean	10.67
SD	5.70

Below the descriptive statistics for the manufacturing cluster as regards the psychosocial questionnaire follow. The quantitative demands are higher than the learning demands in these companies. However both demands are at a moderate level. The role of the workers is clearly defined with very few conflicts. The workers have satisfactory level of control of their work pace and work decisions. The social climate is often supportive and encouraging where the support from the supervisors and co-workers are at high levels. Job satisfaction is at fair levels where job stress is rather low.

Job demands

The scale of the quantitative job demands *(Table 53)* measures time pressure and workload. The workers in manufacturing have not very often workload. Learning demands *(Table 54)* are at lower levels. The quantitative job demands in manufacturing are lower compared to the respective normative values of the psychosocial questionnaire (mean 3.29). However the learning demands were higher compared to the normative values (mean 2.14). Qualitative data reveal that higher learning demands can be attributed to the maintenance and other tasks that production workers must learn to perform during their work. This is called 'multiskilling' in lean production.

Table 53: Quantitative job demands

Question	Mean	SD
Is your workload irregular so that the work piles up?	2.44	1.01
Do you have too much to do?	3.17	0.82
Composite scale score	**2.80**	**0.79**

Table 54: Learning demands

Question	Mean	SD
Are your work tasks too difficult for you?	1.86	0.83
Do you perform work tasks that you need more training?	2.69	0.98
Composite scale score	**2.27**	**0.65**

Quantitative targets were reported achievable *(Table 55).*

Table 55: Quantitative Targets

Question	Mean	SD
Are targets set by the enterprise achievable?	3.32	1.01
Composite scale score	**3.32**	**1.01**

Role expectations

The high average in role clarity *(Table 56)* suggests that duties are clear and expected from the workers. Role clarity was higher than the normative values (mean 4.12). The manufacturing sample rarely faces conflicting tasks (*Table 57)*. However role conflict was higher compared to the normative values (mean 2.24). From the interviews it becomes apparent that although the tasks were standardized and clear the overall lean concept and its constant increase of performance were not as straightforward to the workers.

Table 56: Role clarity

Question	Mean	SD
Have clear, planned goals and objectives been defined for your job?	4.18	0.96
Do you know exactly what is expected of you at work?	4.20	0.90
Composite scale score	**4.20**	**0.84**

Table 57: Role conflict

Question	Mean	SD
Do you receive incompatible requests from two or more people?	2.48	1.11
Composite scale score	**2.48**	**1.11**

Control at work

The workers in the sample have very often positive challenges at their work *(Table 58).* In addition workers have some chances to control important decisions *(Table 59)* and work pace *(Table 60)* at their work. When the possibility to control work rhythm is rare for the employees they face more intense stress symptoms. Control at work values in manufacturing are higher compared to the normative values of the psycho-social questionnaire (mean 2.7 and 2.99 for control of decisions and work pacing re-spectively).

Table 58: Positive challenge at work

Question	Mean	SD
Are your skills and knowledge useful in your work?	3.83	1.02
Is your work challenging in a positive way?	3.89	1.02
Composite scale score	**3.85**	**0.91**

Table 59: Control of decisions

Question	Mean	SD
Can you influence the amount of work assigned to you?	3.03	0.86
Can you influence decisions that are important for your work?	2.90	1.10
Composite scale score	**2.92**	**0.84**

Table 60: Control of work pacing

Question	Mean	SD
Can you set your own work pace?	3.14	1.07
Can you decide yourself when you are going to take a break?	3.17	1.29
Composite scale score	**3.15**	**0.98**

Predictability at work

Manufacturing workers have rather low predictability of their tasks the next month. Knowing in advance the tasks, contributes to stress reduction as it was found after the test *(Table 61).* Predictability at work in manufacturing was considerably lower to the normative values (3.57). This was expected as the companies in the manufacturing sample were basically basing their production on client's demands with the beverage company doing that at a lower level.

Table 61: Predictability during the next month

Question	Mean	SD
Do you know in advance what kind of tasks to expect a month from now?	2.91	1.40
Composite scale score	**2.91**	**1.40**

Mastery of work

Workers are rather often satisfied by their ability to solve problems at work in manufacturing *(Table 62).*

Table 62: Mastery of work

Question	Mean	SD
Are you content with your ability to solve problems at work?	3.87	0.66
Composite scale score	**3.87**	**0.66**

Social interactions

There is often support from the superior in the sample *(Table 63).* Rather frequently workers have support from their co-workers *(Table 64).* Finally the support from friends and relatives *(Table 65)* happens some times and not as often as the support from colleagues. The support from superiors and coworkers is higher in manufacturing compared to the normative values of the questionnaire (mean 3.34 and 3.80 respectively). Indeed that was made apparent in the interviews that superiors and colleagues were supportive to each other for the lean implementation.

Table 63: Support from the superior

Question	Mean	SD
If needed can you get support and help with your work from your immediate superior?	4.14	0.95
Are your work achievements appreciated by your immediate superior?	4.08	1.05
Composite scale score	**4.10**	**0.89**

Table 64: Support from coworkers

Question	Mean	SD
If needed can you get support and help with your work from your coworkers?	4.17	0.90
Composite scale score	**4.17**	**0.90**

Table 65: Support from friends and relatives

Question	Mean	SD
Do you feel that your friends/family can be relied for support when things set tough at work?	3.63	1.28
Composite scale score	**3.63**	**1.28**

Empowering leadership

Manufacturing workers are often encouraged to participate in important decisions or to develop skills *(Table 66).* Empowerment is higher compared to the normative values (mean 2.7). This was confirmed particularly for the electronic company.

Table 66: Empowering leadership

Question	Mean	SD
Does your immediate superior encourage you to participate in important decisions?	3.97	1.00
Does your immediate superior help you develop your skills?	3.94	1.03
Composite scale score	**3.95**	**0.95**

Organisational climate

The climate in manufacturing *(Table 67)* is often encouraging and supportive and less relaxed and comfortable. However the climate can be some times rigid and rule-based. The values are lower compared to the normative values (mean 3.65).

Workers are often encouraged to think of ways to improve work *(Table 68).* In general the climate is often innovative.

It is very rare that workers are not treated equally according to their sex or work experience *(Table 69).* In manufacturing workers are often rewarded for a job well done. In general workers believe that the management cares for their wellbeing *(Table 70).* As far as disturbing conflicts between colleagues it happens rarely *(Table 71).* It has to be mentioned that all workers in the manufacturing sample and at the time of the study were working in a job security situation that facilitated the creation of a positive social climate.

Table 67: Social climate

Question	Mean	SD
Encouraging and supportive?	3.82	0.86
Relaxed and comfortable?	2.70	1.15
Rigid and rule-based?	2.40	1.33
Composite scale score	**2.99**	**0.73**

Table 68: Innovative climate

Question	Mean	SD
Are workers encouraged to think of ways to do things better at your workplace?	**3.98**	**1.02**
Is there sufficient communication in your department?	**3.92**	**0.83**
Composite scale score	**3.95**	**0.82**

Table 69: Inequality

Question	Mean	SD
Have you noticed any inequalities in how men and women are treated at your workplace?	1.64	1.08
Have you noticed any inequalities in how older and younger employees are treated at your workplace?	1.63	1.11
Composite scale score	**1.64**	**0.93**

Table 70: Human resource primacy

Question	Mean	SD
At your organization are you rewarded (money, encouragement) for a job well done?	2.89	1.11
To what extend is the management of your organization interested in the health and well being of the employees?	3.56	1.24
Composite scale score	**3.21**	**1.00**

Table 71: Social relations

Question	Mean	SD
Have you noticed any disturbing conflicts between coworkers?	2,29	1,15
Composite scale score	**2,29**	**1,15**

Group work

In general workers appreciate belonging in the work group *(Table 72).*

Table 72: Group work

Question	Mean	SD
Do you appreciate belonging to your work group or team?	3.79	1.03
Is your group or team successful at problem solving?	3.98	0.72
Composite scale score	**3.89**	**0.69**

Performance monitoring

The workers' performance is controlled often *(Table 73).* Only third of the workers knew the method of control and believed that their superiors are trained to judge their performance according to a prescribed fair way and in confidence *(Table 74).* The majority of the workers reported that they were not consulted for the introduction of performance control.

Table 73: Control of employees' performance

Question	Mean	SD
Is your performance controlled electronically?	3.20	1.12
Composite scale score	**3.20**	**1.12**

Table 74: Information – consultation on performance monitoring

	Yes	No
Have you been informed about the way that your performance is controlled?	33 (82.5%)	7 (17.5%)
Were you consulted for the introduction of the performance control?	28 (71.8%)	11 (28.2%)
Have your comments been considered?	28 (73.7%)	10 (26.3%)
Are your immediate superiors trained to judge your performance according to a prescribed fair way and in confidence?	32 (80%)	8 (20%)

Job satisfaction

Manufacturing workers are often satisfied by their work *(Table 75).* Job satisfaction is considerably higher in manufacturing compared to the normative value (2.6). That was apparent in the interviews.

Table 75: Job satisfaction

Question	Mean	SD
I like to be absorbed in my job most of the time	4.03	0.78
The major satisfaction in my life comes from my job	3.19	1.06
Composite scale score	**3.61**	**0.72**

Stress

Stress is reported rather low in manufacturing *(Table 76).* Stress is the same in manufacturing compared to the respective normative value (2.4).

Table 76: Stress

Question	Mean	SD
Do you feel stress these days?	2.40	1.02
Composite scale score	**2.40**	**1.02**

Table 77 presents the distribution of percentages for the different questionnaire sections in all 5 scales for the manufacturing sector (Very seldom or never, rather seldom, sometimes, rather often, very often). The distribution percentages are also presented for a reduced scale of 3 (merged scale 1 with 2, 3 and merged scale 4 with 5).

The correlations between the sub-sections of the psychosocial questionnaire and the satisfaction from work and the job stress are presented in Table 78.

Table 77: Percentage distributions of items of the QPSNordic 34+

	Percentage distribution of items					Reduced scale percentage distribution of items		
#	1 %	2 %	3 %	4 %	5 %	1&2 %	3 %	4&5 %
Que 1	21.9	32.8	29.7	10.9	4.7	54.7	29.7	15.6
Que 2		16.9	58.5	15.4	9.2	16.9	58.5	24.6
Que 3	40.0	35.4	23.1	1.5		75.4	23.1	1.5
Que 4	12.3	26.2	46.2	10.8	4.6	38.5	46.2	15.4
Que 5	4,8	1,6	28.6	36.5	28.6	6.3	28.6	65.1
Que 6	1,6	7,9	23.8	33.3	33.3	9.5	23.8	66.7
Que 7		8.1	14.5	29.0	48.4	8.1	14.5	77.4
Que 8		6.2	13.8	29.0	46.2	6.2	13.8	75.2
Que 9	20.3	34.4	26.6	14.1	4.7	54.7	26.6	18.8
Que 10	6.7	11.7	56.7	21.7	3.3	18.3	56.7	25.0
Que 11	4.6	24.6	35.4	23.1	12.3	29.2	35.4	35.4
Que 12	10.8	21.5	29.2	16.9	21.5	32.3	29.2	38.5
Que 13	11.1	25.4	31.7	25.4	6.3	36.5	31.7	31.7
Que 14	23.1	16.9	21.5	23.1	15.4	40.0	21.5	38.5
Que 15	9.5	31.7	39.7	7.9	11.1	41.3	39.7	19.0
Que 16		1.6	23.8	60.3	14.3	1.6	23.8	74.6
Que 17	1.6	3.1	14.1	39.1	42.2	4.7	14.1	81.3
Que 18	3.1	3.1	10.8	43.1	40.0	6.2	10.8	83.1
Que 19	4.6	4.6	9.2	41.5	40.0	9.2	9.2	81.5
Que 20	3.1	4.7	18.8	39.1	34.4	7.8	18.8	73.4
Que 21	3.2	4.8	22.2	34.9	34.9	7.9	22.2	69.8
Que 22	7.7	15.4	13.8	32.3	30.8	23.1	13.8	63.1
Que 23		8.2	23.0	47.5	21.3	8.2	23.0	68.9
Que 24	15.0	31.7	30.0	15.0	8.3	46.7	30.0	23.3
Que 25	33.3	25.0	20.0	11.7	10.0	58.3	20.0	21.7
Que 26	3.5	7.0	22.8	40.4	26.3	10.5	22.8	66.7
Que 27		3.1	16.9	58.5	21.5	3.1	16.9	80.0
Que 28	3.1	6.2	15.4	40.0	35.4	9.2	15.4	75.4
Que 29		4.6	24.6	44.6	26.2	4.6	24.6	70.8
Que 30	35.9	32.8	26.6	14.6		68.8	26.6	14.6
Que 31	7.3	14.6	46.3	14.6	17.1	22.0	46.3	31.7

Que 36[6]	6.3	7.9	46.0	27.0	12.7	14.3	46.0	39.7
Que 37	63.9	21.3	6.6	3.3	4.9	85.2	6.6	8.2
Que 38	66.7	17.5	6.3	4.8	4.8	84.1	6.3	9.5
Que 39	17.2	9.4	46.9	20.3	6.3	26.6	46.9	26.6
Que 40	9.5	9.5	22.2	33.3	25.4	19.0	22.2	58.7
Que 43		6.5	58.1	58.1	25.8	6.5	58.1	83.9
Que 44	9.5	14.3	28.6	42.9	4.8	23.8	28.6	47.6
Que 45	23.1	29.2	33.8	12.3	1.5	52.3	33.8	13,8

[6] Here there is a jump between question 31 to question 36 because questions 32-35 refer to performance monitoring and are categorical.

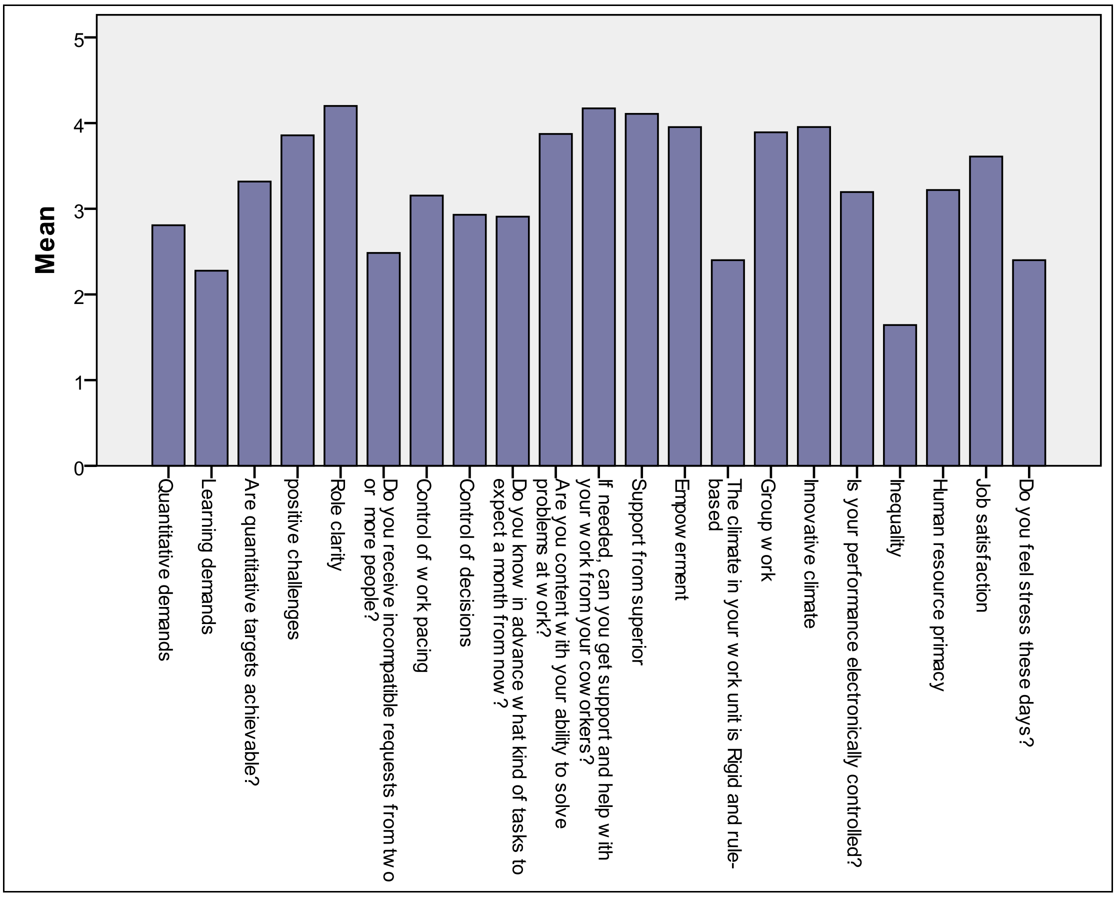


Diagram 6: Mean values of psychosocial factors in manufacturing

Table 78: Correlations between subsections

Sections and subsections	**Job satisfaction**		**Stress**	
Job demands	Correlation coefficient	*p*-value	Correlation coefficient	*p*-value
Quantitative demands	-0.047	0.712	0.248	0.046*
Learning demands	-0.283	0.023*	0.022	0.862
Target achieving	0.203	0.113	0.136	0.289
Role expectations				
Role clarity	0.314	0.012*	0.123	0.329
Role conflict	-0.073	0.568	-0.028	0.825
Control at work				
Positive challenge at work	0.215	0.094	-0.276	0.029*
Control of decisions	-0.040	0.753	0.008	0.952
Control of work pacing	0.049	0.698	-0.187	0.135
Predictability at work				
Predictability during the next month	0.001	0.992	-0.049	0.696
Mastery of work				
Perception of mastery	0.221	0.085	-0.146	0.252
Social interactions				
Support from superior	0.172	0.173	-0.076	0.546
Support from coworkers	0.221	0.081	-0.091	0.474

Empowering Leadership				
Encouragement to take decisions	0.138	0.281	0.088	0.49
Organisational culture				
Social climate:	0.241	0.059	0.161	0.208
Encouraging and supportive			-0.071	0.588
Relaxed and comfortable			-0.141	0.284
Rigid and ruled-based			0.392	0.002**
Innovative climate	0.127	0.318	0.037	0.767
Social relations	-0.267	0.034*	0.003	0.982
Inequality	-0.41	0.751	0.311	0.013*
Group work	0.271	0.030*	-0.033	0.794
Control of employees performance	0.369	0.018*	0.302	0.055

*Correlation is significant at the 0.05 level

**Correlation is significant at the 0.01 level

It is observed that there is a statistically significant positive relation between stress, quantitative demands and inequality and a negative relation with positive challenges at work.

That is *stress is increasing* as:

- quantitative demands are increasing
- inequality is increasing
- rigid and ruled based climate is increasing

Stress is decreasing as:

- positive challenges are increasing at work.

As regards job satisfaction it has statistically significant positive relation with role clarity and the work group and negative relation with learning demands and social relations.

That is *job satisfaction is increasing* as:

- role clarity is increasing
- group efficiency is increasing.

An unexpected positive relation between control of employee's performance and job satisfaction is identified. This can probably be explained because in manufacturing workers seem to have ownership of their achievents. Also workers were consulted on the method of performance monitoring.

Job satisfaction is decreasing as:

- learning demands are increasing
- conflicts among colleagues are increasing.

Statistical controls

The non-parametric control (Mann-Whitney U test) of the other performance control variables showed no statistically significant variable influencing stress or job satisfaction in manufacturing.

The effect of electronic monitoring in the level of satisfaction is presented in table 79. It was found that the employees that have been consulted in the introduction of the monitoring system and their comments were taken into account had a higher job satisfaction level.

Table 79: Job satisfaction and control of performance			
Job satisfaction			
Comments taken into account	**Mean**	**SD**	***p* value**
Yes	3.57	0.78	0.021
No	2.66	1.00	0.021

Explanatory models

There was an effort to model stress as dependent variable with explanatory variables the quantitative demands, the positive challenges, the rigid and rules based social climate and inequalities.

The stepwise regression to test the hypotheses regarding stress in the manufacturing case is presented in the table 80. There is no evidence of collinearity, with all VIF values within 1.5.

The only variables that can somehow explain stress are positive challenges with a negative relation (p=0.045) and rigid and rules based social climate with a positive relation (p=0.002). The model F is 7.602 (df=57), p=0.001 and R Square =21.7% and adjusted R Square =18.8%.

The hypotheses 1 and 2 that job stress is positively related to job demands and performance monitoring respectively in lean environments are not supported in the manufacturing case. Performance monitoring was not correlated to stress and not included at all in the model. Quantitative demands were excluded from the model.

Table 80: Explanatory model for Job stress

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	1.687	.264		6.381	.000	1.157	2.216		
	Rigid and ruled based climate	.315	.098	.396	3.226	.002	.119	.511	1.000	1.000
2	(Constant)	2.814	.607		4.634	.000	1.597	4.031		
	Rigid and ruled based climate	.303	.095	.380	3.179	.002	.112	.493	.996	1.004
	Positive challenges	-.283	.138	-.245	-2.050	.045	-.560	-.006	.996	1,004

There was an effort to model job satisfaction as dependent variable with explanatory variables the learning demands, role clarity, conflicts at work, group work and performance monitoring.

The stepwise regression to test the hypothesis regarding job satisfaction in the manufacturing case is presented in *Table 81*. There is no evidence of collinearity, with all VIF values below 1.5. Job satisfaction is partly explained by job demands with a negative relation. The model F is 9.848 (df=40), p=0.003 and R Square =20.2% and adjusted R Square =18.1%.

This was also evident in the interviews. Increasing learning demands was bringing discontent to the workers particularly combined with limited training. However, most probably, the support that workers received from their peers and superiors prevented the association of some psychosocial factors to stress.

Table 81: Explanatory model for Job satisfaction

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	4.903	.413		11.883	.000	4.069	5.738		
	Learning demands	-.531	.169	-.449	-3.138	.003	-.874	-.189	1.000	1,000

a. Dependent Variable: Job satisfaction

5.2.2.3 Musculoskeletal disorders

Only the beverage company from the manufacturing cluster accepted the musculoskeletal questionnaire. Twenty six persons completed the questionnaire for the MSD symptoms. Data for the working experience, working time, weight and other were collected.

MSD symptoms

From symptoms reporting (ache, pain, discomfort) the last 12 months in the musculoskeletal system, the workers that completed the questionnaire in the beverage company suffer from symptoms in the shoulders (20%), hips (21%), wrists/hands (20%), neck (13%), elbows (13%), lower back (13%) and upper back (4%), feet (13%) and knees (8%). The data are presented in detail in *Table 82*.

In *Table 83*, the results of the symptoms experienced by the workers the last 12 months and prevent them from completing their work are presented. In *Table 84* the frequencies of the symptoms of the last 7 days are presented.

It was found that from the 3 workers reporting lower back symptoms the last 12 months, one of them couldn’t complete his work due to these complaints.

Respectively from the 5 workers reporting symptoms in the hips one of them couldn’t complete his work due to these complaints. No one suffered any of the reported symptoms the last 7 days.

In the following tables the results for the whole musculoskeletal system are presented.

Table 82: Musculoskeletal symptoms the last 12 months to:			
		Frequency	**Percentage %**
Neck	No	20	87.0
	Yes	3	13.0
Shoulders	No	19	79.2
	Yes in the right shoulder	2	8.3
	Yes in the left shoulder	2	8.3
	Yes in both shoulders	1	4.2
Elbows	No	20	87.0
	Yes in the right elbow	3	13.0
	Yes in the left elbow	0	0
	Yes in both elbows	0	0
Wrists/hands	No	18	81.8
	Yes in the right wrist/hand	3	13.6
	Yes in the left wrist/hand	1	4.5
	Yes in both wrist/hands	0	0
Upper back	No	22	95.7
	Yes	1	4.3
Lower back	No	20	87.0
	Yes	3	13.0
One or both Hips	No	18	78.3
	Yes	5	21.7
One or both knees	No	22	91.7
	Yes	2	8.3
One or both ankles /feet	No	19	86.4
	Yes	3	13.6

Table 83: Have you at any time during the last 12 months been prevented from doing your normal job because of the trouble?			
		Frequency	**Percentage %**
Neck	No	7	100.0
	Yes	0	0
Shoulders	No	5	100.0
	Yes	0	0
Elbows	No	6	100.0
	Yes	0	0
Wrists/hands	No	7	100.0
	Yes	0	0
Upper back	No	4	100.0
	Yes	0	0
Lower back	No	4	80.0
	Yes	1	20.0
One or both hips	No	7	87.5
	Yes	1	12.5
One or both knees	No	4	100.0
	Yes	0	0
One or both ankles/feet	No	5	100.0
	Yes	0	0

Table 84: Have you had troubles at any time during the last 7 days?			
		Frequency	**Percentage %**
Neck	No	5	100.0
	Yes	0	0
Shoulder	No	5	100.0
	Yes	0	0
Elbows	No	5	100.0
	Yes	0	0
Wrists/hands	No	6	100.0
	Yes	0	0
Upper back	No	3	100.0
	Yes	0	0
Lower back	No	4	100.0
	Yes	0	0
One or both hips	No	7	100.0
	Yes	0	0
One or both knees	No	3	100.0
	Yes	0	0
One or both ankles/feet	No	4	100.0
	Yes	0	0

Statistical controls

Statistical controls were made between MSD and work characteristics. The control was made at the sample of employees that replied to the psychosocial and the MSD questionnaires.

Statistical comparison was made for stress and MSD symptoms. The persons that reported pain in the shoulders the last 12 months reported statistically significant higher levels of stress.

Table 85: MSD symptoms and stress

Variable		Mean	SD	*p*-value
Pain in the shoulder (any shoulder) the last 12 months	No	2.05	0.76	0.026
	Yes	2.80	0.44	0.026

Also comparison was made for the work characteristics and the MSD symptoms. No statistically significant differences were found for quantitative and learning demands, role conflict and control of decisions or work pacing.

Finally comparison was made for the performance monitoring and the MSD symptoms. Significant percentage of the persons that were not informed or consulted or their comments were taken into account for the performance monitoring methods at their work reported pain in the neck and in the shoulders.

Table 86: MSD symptoms (pain in the neck) and information for performance monitoring

Pain in the neck the last 12 months			
Information for the method of the performance monitoring	No	Yes	**Total**
Yes	17 (94.4%)	1 (5.6%)	**18 (100%)**
No	1 (33.3 %)	2 (66.7 %)	**3 (100)**
Total	**18 (85.7%)**	**3 (14.3)**	**21 (100%)**
p-value = 0.041			

Table 87: MSD symptoms (pain in the shoulders) and information for performance monitoring

Pain in the shoulders the last 12 months			
Information for the method of the performance monitoring	No	Yes	**Total**
Yes	18 (90%)	2 (10%)	**20 (100%)**
No	0 (0%)	2 (100%)	**2 (100%)**
Total	**18 (81.8%)**	**3 (18.2%)**	**22 (100%)**
p-value = 0.026			

Table 88: MSD symptoms (pain in the neck) and consultation for performance monitoring

Pain in the neck the last 12 months			
Consultation for the method of the performance monitoring	No	Yes	**Total**
Yes	17 (94.4%)	1 (5.6%)	**18 (100%)**
No	1 (33.3%)	2 (66.7%)	**3 (100%)**
Total	**18 (81.8%)**	**3 (18.2%)**	**21 (100%)**
p-value = 0.041			

Table 89: MSD symptoms (pain in the shoulders) and comments taken into account during consultation for performance monitoring

Pain in the shoulders the last 12 months			
Comments taken into account during consultation for the method of the performance monitoring	No	Yes	**Total**
Yes	17 (94.4%)	1 (5.6%)	**18 (100%)**
No	0 (0%)	3 (100%)	**3 (100%)**
Total	**17 (81%)**	**4 (19%)**	**21 (100%)**
p-value = 0.03			

Explanatory model for MSD symptoms

A logistic regression was made with dependent variables the MSD symptoms and explanatory variables stress and performance monitoring.

The pain in the neck the last 12 months was tested as dependent variable with explanatory variables the stress and information concerning the way of performance monitoring. It was found that those not informed about the method of performance monitoring had a manifold (34 times) risk of having pain (p=0.027). However the results concern only one company -the beverage company- with a fairly small sample.

Table 90: Pain in the neck the last 12 months

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	Information for the performance monitoring	3,526	1,600	4,860	1	.027	34,000	1,479	781,787
	Constant	-6,360	2,395	7,052	1	.008	,002		

The hypothesis 7 for positive relation of MSDs with quantitative demands was not supported in manufacturing. The hypothesis 8 for positive relation of MSDs with performance monitoring is supported as regards information of the method of monitoring. Hypothesis 9 that stress is predictor of MSD symptoms in lean manufacturing is not supported.

5.2.2.4 Discussion for manufacturing cluster

The research hypotheses were poorly supported in manufacturing *(Table 91).* Quantitative demands (Hypothesis 1) were rejected as predictors of job stress. However, qualitative data from the interviews revealed that there were time pressures in the establishments in the sample, particularly in the metal and electronics industry. The beverage company, for example, had significantly increased the work pace when it reached advanced lean implementation level. However administration of questionnaires to compare the effects of the new situation to the old one was not possible.

The rejection of this hypothesis is not consistent with earlier research in manufacturing. In the Conti et al. (2006) study in 21 lean industry sites, work pace/intensity was strongly associated with job stress. Jackson & Mullarkey (2000) also reported production pressure to be a strong predictor of job related strain in lean garment manufacture. Seppola & Klemola (2004) also found that quantity of work predicted experiences of stress. However, Jackson & Martin (1996), in line with this study, showed increased production pressure but no associated increase in psychological strain in electronic industry.

One explanation for this result may be that the control and support at work characteristics that are reported often in manufacturing could have had mediating effects on stress. Hypothesis 3 -Job stress is negatively related to control of work- is partly supported since control of work pacing and control of decisions were not significant in relation to stress. Only skill utilization (positive challenges) from the control variables partly predicted stress in manufacturing (negative association to stress). This finding differs from the Jackson & Mullarkey (2000) study that reported that lack of control by a group over work methods was a significant predictor of stress. Parker (2003) found mediation of stress by a number of work autonomy characteristics (control of timing and methods of activities) including skill utilization in lean assembly lines.

Stress is also explained in this case by rigid and rules based climates (negative relation). Seppola & Klemola (2004) also found a poor social climate to be a significant predictor of stress but only for blue-collar employees in lean manufacturing.

Hypothesis 2 on the positive relation of performance monitoring to stress was rejected. This can be explained because in the interviews the more critical to the workers was their participation in monitoring performance.

Job satisfaction is partly explained by learning demands with a negative relation. Learning demands increase as task variation is increasing in lean production. Although workers were in general happy with the possibility to learn new skills what they ended up doing was multitasking. The lack of knowledge of new tasks due to the limited training time was frustrating. Also some workers experienced multitasking as deskilling.

Hypothesis 6 (the association of quantitative demands with MSD development) was also rejected. This differs from the study by Landsbergis et al. (1999) that concluded that intensified work pace and demands may lead to physical exhaustion and musculoskeletal disorders. Brenner et al. (2004) in line with Landsbergis found in his study a positive relationship of MSDs with JIT practices that are associated with time pressure.

The interviews and observations in the manufacturing sample revealed that physical risk factors for MSD had increased with lean production (e.g. manual handling, repetitiveness, strenuous postures) although the opposite was anticipated. The latter is in accordance with findings of other studies in lean sites (Caroly et al. 2010, Christmansson, Friben and Sollerman, 1999, Lloyd & James, 2008, Schouteten & Benders, 2004, etc.). The study by Womack et al. (2009) differs because they found a lower global index for MSD risk factors in lean assembly lines compared to non-lean (greater repetition exposure but lower peak hand force). The results for the MSD symptoms are from only one of the three companies and there were specific reasons why there is no relationship. The beverage company had the lowest lean score of all in the manufacturing sample.
Hypothesis 7 was partly supported. It was found that those not informed about the method of performance monitoring had a manifold (34 times) risk of having pain in the neck. Here information on production monitoring methods is identified as a mediator between ergonomic and psychosocial risks and health effects and in particular MSD symptoms. The mediation effects of information and workers' participation for reducing stress from restructuring are reported by Westgaard and Winkel, (2011).

Hypothesis 8 was rejected because stress was not a predictor of MSD symptoms. However, Christmansson, Friben and Sollerman, (1999), concluded that stable or increased MSDs after lean implementation was due to a combination of physical factors and a poorer psychosocial environment and not directly connected to reports of stress.

Table 91: Summary of findings in manufacturing

Hypothesis 1:	Rejected/ Quantitative demands are not predictors of job stress in lean manufacturing
Hypothesis 2:	Rejected/Performance monitoring in manufacturing is not significant for predicting stress
Hypothesis 3:	Partly supported/ Job stress is associated with lower positive challenges at work
Hypothesis 6:	Rejected/ Quantitative demands are not predictors of MSD symptoms
Hypothesis 7:	Partly supported/Information on performance monitoring is a predictor for neck symptoms
Hypothesis 8:	Rejected/ Stress is not a predictor of MSD symptoms in manufacturing

The interaction model of lean characteristics, effects on stress, MSDs and positive outcomes presented in section 4.3 is re-examined in the manufacturing case (Figure 7).

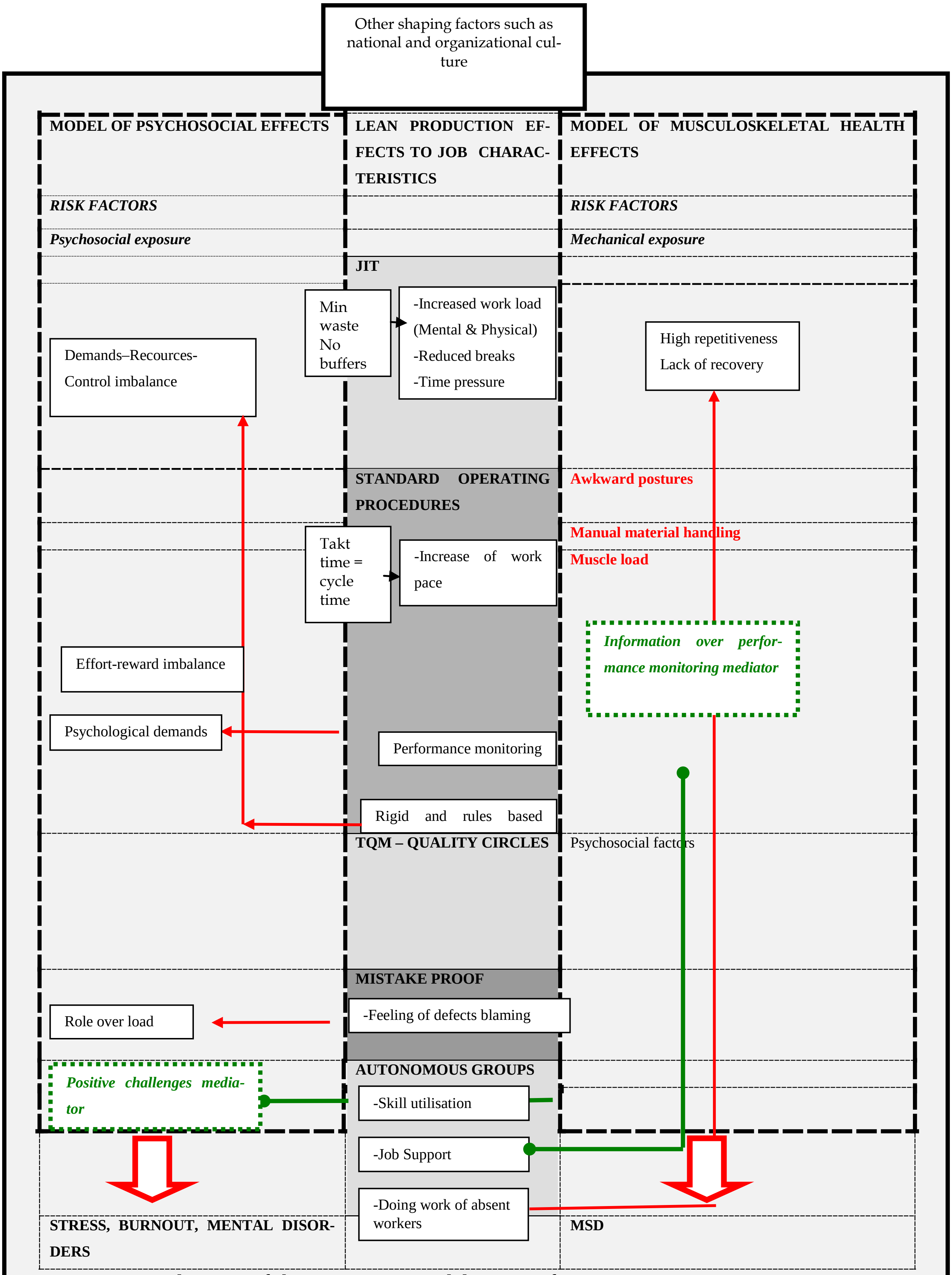


Figure 7: Application of the interaction model to manufacturing

The significant relations will be illustrated and the non-significant relations will be omitted. Quantitative demands although identified in the interviews and site visits were not significantly shown to be physical or psychosocial stressors. Feeling of defects blaming was confirmed in the manufacturing sample. No psychosocial effect on MSD development was found to be significant. However, manual handling and other physical risk factors are not reduced by lean production; on the contrary they are increased. The effort-reward imbalance is not valid since workers do not feel exploited by new improvement ideas. Positive challenges from work (utilization of workers' skills and suggestions of new improvements in production) are buffers to stress. Moreover information on performance monitoring is identified as a mediator of neck pain.

In conclusion the research hypotheses are poorly supported in lean manufacturing (2 out of 6). Quantitative demands are not predictors of job stress not consistently with similar studies that reported differently. This result can probably be explained by the fact that workload was not so critical in the manufacturing sample. Although workload was relatively high, it seems that the rigid and rules based organizational climate was far more stressful to the workers. Also positive challenges from work had mediating effects to job stress. A number of studies have also identified job control characteristics as stress mediator. Performance monitoring was not significant for explaining stress that was expected since it is not so intense in manufacturing. Stress was not associated to MSDs symptoms. Neither high workload could explain MSD symptoms. However, mechanical exposure (MSD physical risk factors) seems to be increased after lean implementation although the opposite was aimed at. Information for the performance monitoring is identified as a mediator to neck pain. Thus the interaction model between lean characteristics and effects to stress and MSDs is applicable to this manufacturing cluster with fewer connections.

5.2.3 COMPARISON BETWEEN SECTORS

This study aims at examining the effects of lean implementation on health and safety in different type of sectors. Demographics, psychosocial variables and MSD symptoms have been examined in manufacturing and services (in particular call centres). In this section a comparison will be made of the results for the call centres and manufacturing.

An Anova analysis demonstrated a statistically significant different mean age of employees between sectors. The employees in the call centres are younger than those in manufacturing. This may be explained by the nature of the work and the high turnover in the sector.

Table 92: Age between sectors

Sector	Mean Age	SD	*p-value*
Call Centres	27.18	5.92	0.000
Manufacturing	34.21	7.24	0.000
Total	28.10	6.54	

A Chi square test demonstrated a statistically significant different sex distribution between sectors. Manufacturing is male dominated whereas in call centres women dominated. The sex segregation in call centres and manufacturing is confirmed by relevant studies.

Table 93: Sex distribution between sectors

SEX			
	Call centre	Manufacturing	**Total**
Men	77 (26.7%)	45 (93.8%)	**122 (100%)**
Women	211 (73.3%)	3 (6.2%)	**214 (100%)**
Total	**288 (100%)**	**48 (100%)**	**336 (100%)**
***p*-value = 0.000**			

5.2.3.1 Psychosocial questionnaire

Statistical tests were run to investigate significant differences in psychosocial variables between sectors. A Mann Whitney U test showed statistically significant differences for learning demands, positive challenges, control of decisions, support from superior, empowerment, group work, inequality, human resource primacy, innovative climate, predictability, performance monitoring and job satisfaction between call centres and manufacturing.

The psychosocial environment seems to be better in the majority of its variables in the manufacturing sector compared to call centres. However, differences in critical psychosocial aspects such as quantitative demands (p=0.507), control of work pacing (p=0.181) and more importantly, manifestations of stress (p=0.141) were not significant.

Exceptions where manufacturing has worse working condition are the learning demands *(Table 94)* that are higher in manufacturing (p=0.001) and predictability *(Table 95)* that is respectively lower (p=0.000). This may be because the call centre operators in yellow pages had relatively easy tasks and low learning demands. The yellow pages operators outnumbered the operators in the technical services who have more complicated tasks and did not receive adequate training.

Table 94: Learning demands between sectors

Sector	Mean	SD	*p-value*
Call centres	1.93	0.91	0.001
Manufacturing	2.27	0.65	0.001

Table 95: Predictability between sectors

Sector	Mean	SD	*p-value*
Call centres	4.05	1.35	0.000
Manufacturing	2.91	1.40	0.000

In the lean manufacturing companies, Just in Time systems did not allow workers to predict their tasks the following month. This was particularly the case in the metal and electronics industries. Predictability on the other hand was higher in call centres. Although JIT is also implemented in the call centres the operators' tasks were more specific and therefore expected.

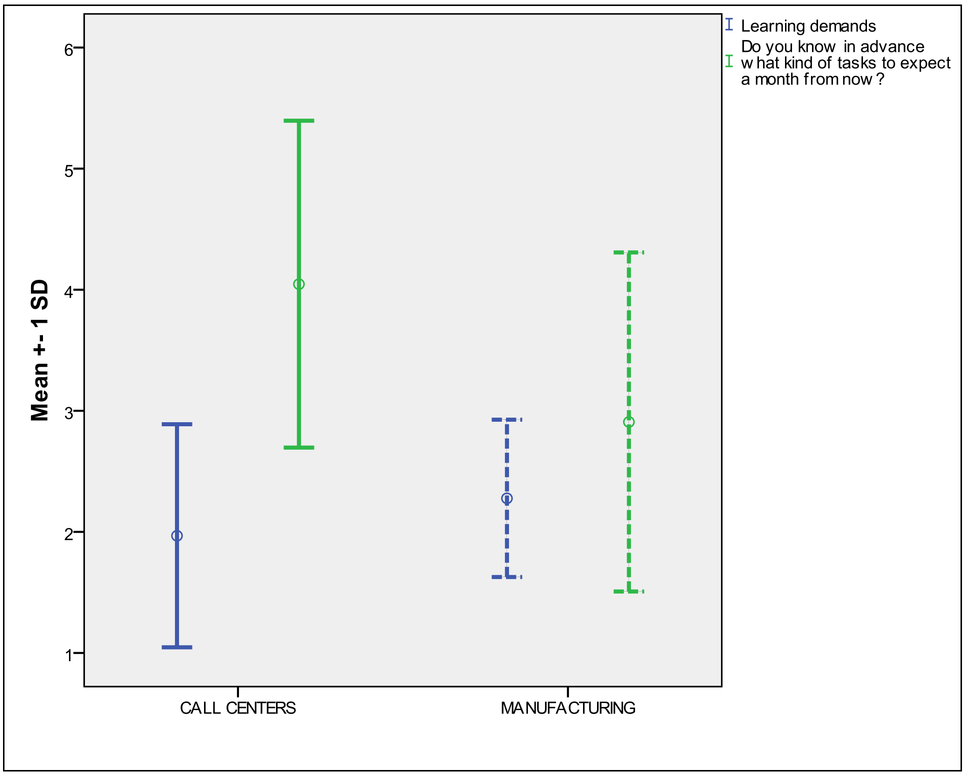


Diagram 7: Differences of learning demands and predictability between sectors

Positive challenges *(Table 96)* were found to be higher in manufacturing (p=0.001). This variable was found to explain stress (negative relation) in the sector where it was not included in the explanatory model for stress in the call centres.

Table 96: Positive challenges between sectors

Sector	Mean	SD	*p-value*
Call centres	2.78	1.10	0.000
Manufacturing	3.85	0.90	0.000

Workers in manufacturing have higher control of decisions *(Table 97)* (*p*=0.000) and better support by superiors *(Tables 98)* (*p*=0.000). In call centres team leaders were very reluctant to participate in this study and they felt that their supervision abilities were being questioned. Call centre operators felt that they rarely could count on superiors to solve a problem. On the contrary, problems encountered with customers were registered in their monthly performance as bad records. Employees from the technical call centre during the interviews suggested creating a service where some difficult questions would pass directly to more experienced employees or would be dealt with only by employees in the telecommunication shops.

Table 97: Control of decisions between sectors

Sector	Mean	SD	*p-value*
Call centres	2.00	0.92	0.000
Manufacturing	2.92	0.84	0.000

Table 98: Support from superior between sectors

Sector	Mean	SD	*p-value*
Call centres	3.66	0.92	0.000
Manufacturing	4.10	0.89	0.000

Teams in manufacturing are more efficient compared to the ones in call centres (*p*=0.017). In call centres, according to the interviews regarding information on performance control, there was suspicion that the management was applying different criteria for operators. Employees in the technical call centre had accused the management of favouring some workers by giving them night shifts and therefore an additional bonus. This had created a bad climate among employees and no feeling of belonging to a group. Not surprisingly inequality was higher in call centres compared to manufacturing (*p*=0.000).

Table 99: Group work between sectors

Sector	Mean	SD	*p-value*
Call centres	3.59	0.88	0.017
Manufacturing	3.89	0.69	0.017

Table 100: Inequality between sectors

Sector	Mean	SD	*p-value*
Call centres	2.39	1.16	0.000
Manufacturing	1.64	0.93	0.000

Innovation is embraced in manufacturing (p=0.000). Workers in production feel more empowered *(Table 102)* compared to the call centre operators (p=0.000). In call centres operators were not encouraged to develop new skills. The employees only received the necessary training to respond to the customers. After a period operators were moved to new departments. Therefore the skills required especially in the yellow pages remained always low.

Table 101: Innovative climate between sectors

Sector	Mean	SD	*p-value*
Call centres	3.05	0.93	0.000
Manufacturing	3.95	0.82	0.000

Table 102: Empowerment between sectors

Sector	Mean	SD	*p-value*
Call centres	2.13	1.08	0.000
Manufacturing	3.95	0.95	0.000

Production workers felt they had a better balance of effort and reward *(Table 103)* and enjoyed interest from the management (p=0.000). Call centre operators on the contrary were considered as ‘dispensable’ due to the high turnover. Particularly in the national telecommunication company job insecurity was high. Operators were laid off periodically and hired again to prevent them from gaining employment rights (i.e. a permanent contract).

Table 103: Human resource primacy between sectors

Sector	Mean	SD	*p-value*
Call centres	2.44	0.90	0.000
Manufacturing	3.21	1.00	0.000

Performance monitoring as expected is more intensive in call centres (p=0.000). Electronic monitoring exists in call centres with strict and mostly quantitative criteria. Employees would have preferred to be judged by qualitative criteria such as surveillance of phone calls by team leaders. In manufacturing performance monitoring exists but it is not electronic.

Table 104: Performance monitoring between companies

Sector	Mean	SD	*p-value*
Call centres	4.42	0.95	0.000
Manufacturing	3.20	1.12	0.000

Job satisfaction is significantly higher for manufacturing workers compared to the call centre operators *(p=0.000).* This can be explained by the feelings of ownership manufacturing workers had and support from their foremen and colleagues that were evident in the interviews. Also job security was reassured in those companies.

Table 105: Job satisfaction between companies

Sector	Mean	SD	*p-value*
Call centres	2.71	1.06	0.000
Manufacturing	3.60	0.72	0.000

However, this comparison of findings is applicable to this sample of companies and cannot be generalised in the population. No safe conclusion can be drawn that manufacturing companies implementing lean production have in general better psychosocial environments compared to call centres. However, call centres are considered as lean service systems. In particular employees that experience – as in this case study - performance monitoring and dialogue scripting show higher levels of stress (Sprigg & Jackson, 2006).

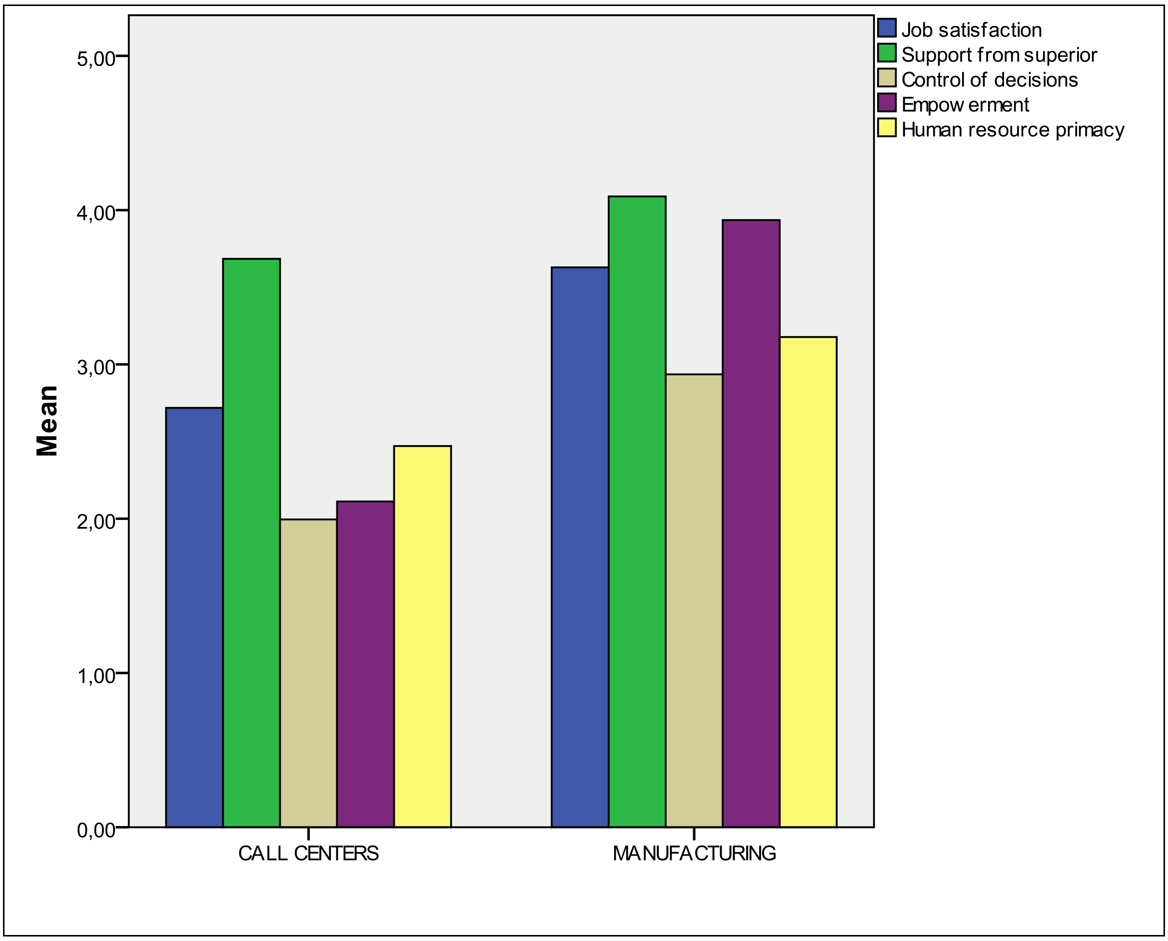


Diagram 8: Differences of job control and support characteristics between sectors

5.2.3.2 Musculoskeletal questionnaire

Employees in the call centres report statistically significant more often MSD symptoms compared to workers in manufacturing. However only one company - the beverage company- used the MSD questionnaire and returned only a small sample and this is all that represents the manufacturing cluster. Nevertheless a chi square test showed that pain in the neck (*p*=0.000), the shoulders (*p*=0.006), wrists/hands (*p*=0.013), upper (*p*=0.038), and lower back (*p*=0.042), the last 12 months, are more often experienced by call centre operators compared to industry workers. This result differs from the Brenner et al study (2004) that found more significant effects of lean characteristics on MSDs in manufacturing compared to non-manufacturing establishments. They reported a MSD rate of 1.2 cases per 100 workers in manufacturing in contrast to a rate of only 0.07 in non-manufacturing sectors. This inconsistency is most probably due to the size of the manufacturing sample in this study and to the fact that the comparison was call centres rather than all non-manufacturing establishments.

Table 106: Symptoms of pain in the neck between sectors

Pain in the neck the last 12 months			
	Call centre	Manufacturing	**Total**
No	85 (42.1%)	20 (87.0%)	**105 (100%)**
Yes	117 (57.9%)	3 (13.0%)	**120 (100%)**
Total	**288 (100%)**	**23 (100%)**	**336 (100%)**
***p*-value = 0.000**			

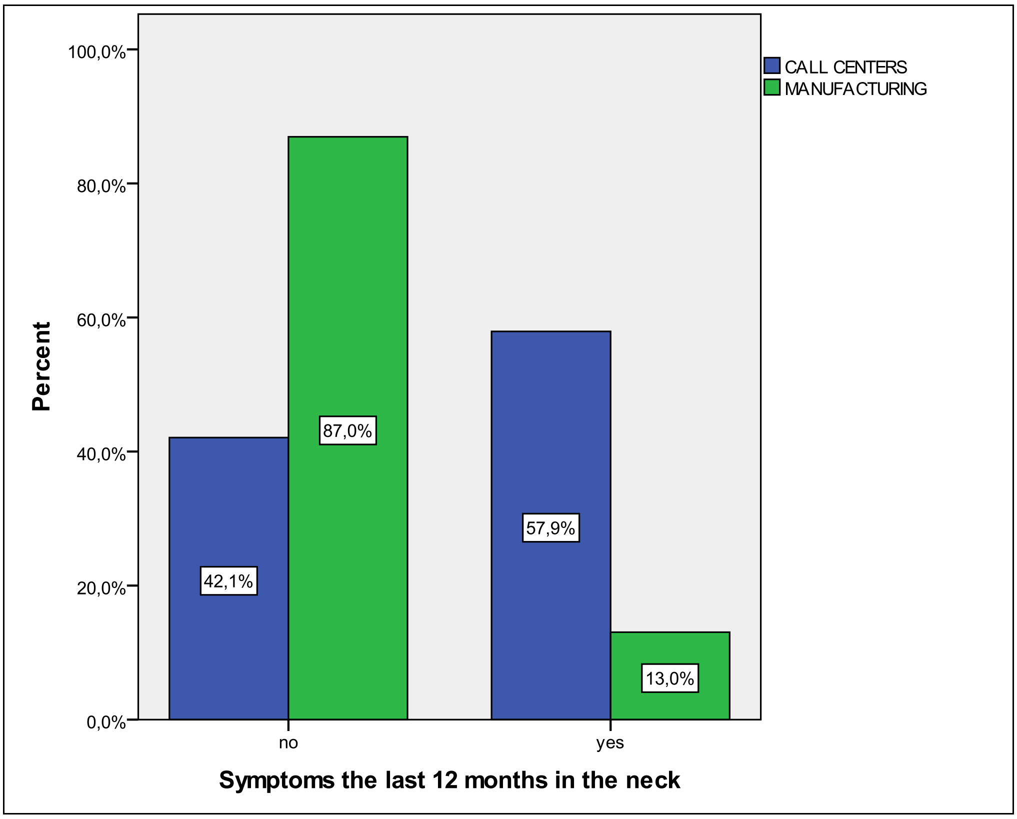


Diagram 9: Differences of symptoms in the neck between sectors

Table 107: Symptoms of pain in the shoulders between sectors

Pain in the shoulders the last 12 months			
	Call centre	Manufacturing	**Total**
No	101 (50.8%)	20 (80.0%)	**121 (100%)**
Yes	98 (49.2%)	5 (13.0%)	**103 (100%)**
Total	**199 (100%)**	**25 (100%)**	**224 (100%)**
***p*-value = 0.006**			

Table 108: Symptoms of pain in the wrists/hands between sectors

Pain in the wrists/hands the last 12 months			
	Call centre	Manufacturing	**Total**
No	108 (54.3%)	18 (81.8%)	**126 (100%)**
Yes	91 (57.9%)	4 (13.0%)	**95 (100%)**
Total	**199 (100%)**	**22 (100%)**	**221 (100%)**
***p*-value = 0.013**			

Table 109: Symptoms of pain in the upper back between sectors

Pain in the upper back the last 12 months			
	Call centre	Manufacturing	**Total**
No	151 (77.0%)	22 (95.7%)	**173 (100%)**
Yes	45 (23.0%)	1 (4.3%)	**95 (100%)**
Total	**196 (100%)**	**23 (100%)**	**219 (100%)**
***p*-value = 0.038**			

Table 110: Symptoms of pain in the lower back between sectors

Pain in the lower back the last 12 months			
	Call centre	Manufacturing	**Total**
No	131 (66.2%)	20 (87.0%)	**151 (100%)**
Yes	67 (33.8%)	3 (13.0%)	**70 (100%)**
Total	**198 (100%)**	**23 (100%)**	**221 (100%)**
***p*-value = 0.042**			

Quantitative demands are associated to increased stress in call centres. Control of work pacing is a significant modifier that can reduce job stress. Stress is also a predictor of MSD symptoms in call centres.

The differences in job demands between the sectors -with the exception of learning demands that are higher in manufacturing- were not significant. However modifying factors of stress like support from superiors and control of decisions were higher in the manufacturing lean environments.

Performance monitoring a critical lean characteristic that strongly correlates with stress is considerably higher as expected in call centres. Differences in psychosocial outcomes were controversial. Stress difference was not significant among sectors where job satisfaction was significantly higher in manufacturing. High job satisfaction can be explained by job security, high empowerment and better balance of effort and reward in manufacturing workers.

Health effects such as MSD symptoms were stronger in the call centres. More specifically call centre operators reported more often pain in the neck, the shoulders, wrists/hands, upper and lower back in the last 12 months. Age was not a confounding *factor for MSD development since employees in call centres were significantly younger compared to workers in manufacturing.*

Psychosocial environment and MSD symptoms reports seem to be better in manufacturing compared to services sector (call centres) implementing lean practices. However, these findings should be treated with caution because of the small size of the sample from the manufacturing sector.

5.2.4 LEAN IMPLEMENTATION AND STRESS

The main research hypotheses of this study are that increases in the level of lean implementation (leanness) leads to greater job demands and greater stress (Hypotheses 4 & 5). Different companies were given a lean score after interviewing lean managers for lean practices implementation *(Table 111).* Both telecommunication call centres received the same lean score since the lean implementation was quite similar. However in these statistical controls only the national telecommunication company -that completed the psychosocial questionnaire- was included.

Table 111: Level of lean implementation in the sample

	Manufacturing			**Services**
	Metal industry	**Beverage Industry**	**Electronics**	**Call centers**
Lean characteristics				
Set up reduction	✔	✔	✔	-
Inventory and waste reduction (Kanban Pull signals)	***some***	***little***	✔	✔
Supplier partnerships	***some***		✔	
Continuous Improvement Program	✔	✔	✔	✔
Mixed-Model production / (Continuous flow – Cellular production)	-	-	✔	✔
Total Quality Management	✔	✔	✔	✔
Mistake proof (poka-yoke)	✔	✔		✔
Total Preventive Maintenance	✔	***some***	✔	
Standard Operating Procedures (SOP)		✔	✔	✔
TOTAL	**FAIR 3,6**	**MODERATE 2,4**	**ADVANCED 5**	**FAIR 3,5**

The results show that the level of lean implementation has a positive relation with quantitative demands. As leanness increases there is an increase in work pace. However, the potential to control decisions and work pacing is also increasing. This potential could act as a buffer to reduce the effects of time pressure on stress. Also performance monitoring increases as lean implementation increases. However, there is no linear correlation between leanness, job demands, stress and job satisfaction. The correlation (Spearman rho) for leanness and job characteristics is in *Table 112.*

Table 112: Correlations for leanness

Sections and subsections	**Leanness**	
Job demands	Correlation coefficient	*p*-value
Quantitative demands	0.248	0.001**
Learning demands	-0.016	0.827
Target achieving	0.190	0.016*
Role expectations		
Role clarity	-0.005	0.950
Role conflict	0.067	0.380
Control at work		
Positive challenge at work	0.093	0.220
Control of decisions	0.259	0.001**
Control of work pacing	0.250	0.001**
Predictability at work		
Predictability during the next month	-0.061	0.423

Mastery of work		
Perception of mastery	-0.022	0.789
Social interactions		
Support from superior	-0.073	0.330
Support from coworkers	0.041	0.585
Empowering Leadership		
Encouragement to take decisions	0.048	0.532
Organisational culture		
Social climate:	0.223	0.003**
Encouraging and supportive		
Relaxed and comfortable		
Rigid and ruled-based		
Innovative climate	0.013	0.863
Social relations	0.212	0.005**
Group work	0.078	0.306
Control of employees performance	0.367	0.000**
Stress	0.030	0.687
Job satisfaction	0.086	0.258

*Correlation is significant at the 0.05 level

**Correlation is significant at the 0.01 level

Explanatory model of stress and job characteristics

Analysis of the relationship between job characteristics, stress and leanness revealed a high degree of non-linearity. The best fit was achieved with quadratic curves shown in the following figures. That way stress and other job characteristics with non-linear relationship to lean implementation were controlled for a quadratic curve fit.

Stress

The hypothesis 4 is rejected since the relationship of lean implementation with stress is more complex than originally hypothesised. The quadratic curve is shown in *Diagram 10* (F=6.75, df=176, p=0.002, R square=7.2%, adjusted R square=6.1%).

At low levels of implementation stress is increasing. At a middle level of implementation; stress is reaching a peak point to decrease with advanced implementation. However there is only one company with advanced lean implementation from which to reach these conclusions. Nevertheless, this finding is consistent with the findings of Conti et al. (2006) with a fair sample of lean companies (21). (Conti et al. mean lean implementation level 3.7/ this study mean implementation level 3.62).

Table 113: Explanatory model for Stress

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	-3.185	1.775		-1.795	.074	-6.688	.318
	Leanness	3.458	.992	1.599	3.487	.001	1.501	5.415
	leansqr	-.500	.138	-1.664	-3.627	.000	-.773	-,228

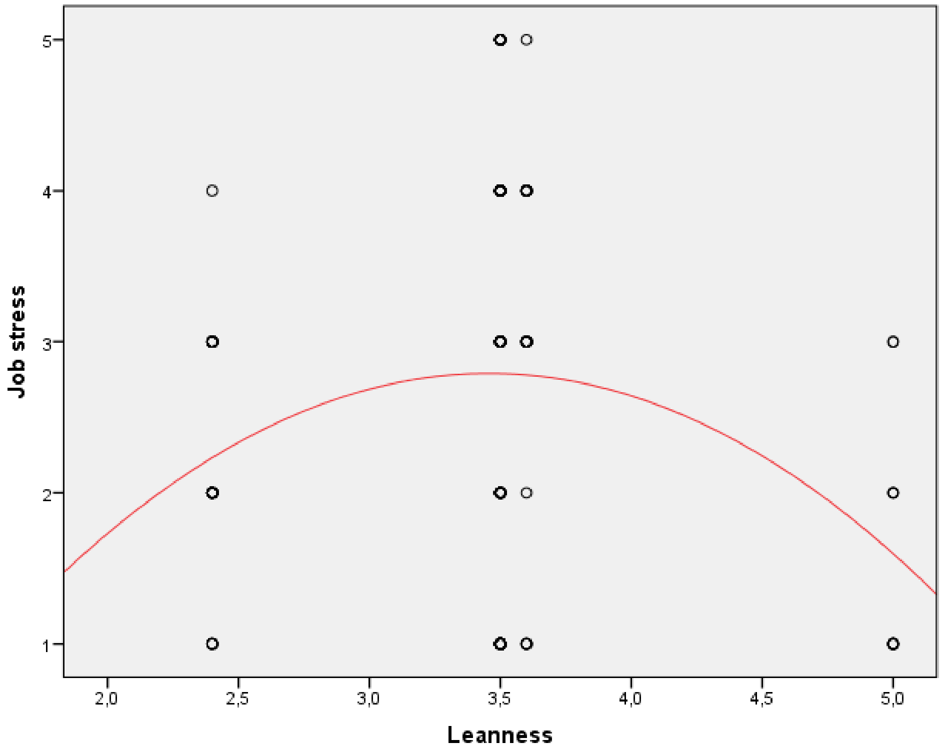


Diagram 10: Leanness and stress

Job demands

The regression model for explaining quantitative or learning demands with leanness was not significant.

Job satisfaction

Job satisfaction follows an inverse curve of the stress curve. *(Diagram 11)* (F=4.382, df=176, p=0.014, R square=4.8%, adjusted R square=3.7%). Job satisfaction is dropping as lean implementation is increasing. At a middle point it reaches its lower point and then starts to level up with advanced lean implementation. The sample size again limits the degree to which these results can be generalised.

Table 114: Explanatory model for Job satisfaction

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	7.286	1.441		5.055	.000	4.441	10.131
	Leanness	-2.324	.805	-1.341	-2.886	.004	-3.913	-.735
	leansqr	.307	.112	1.275	2.744	.007	.086	,528

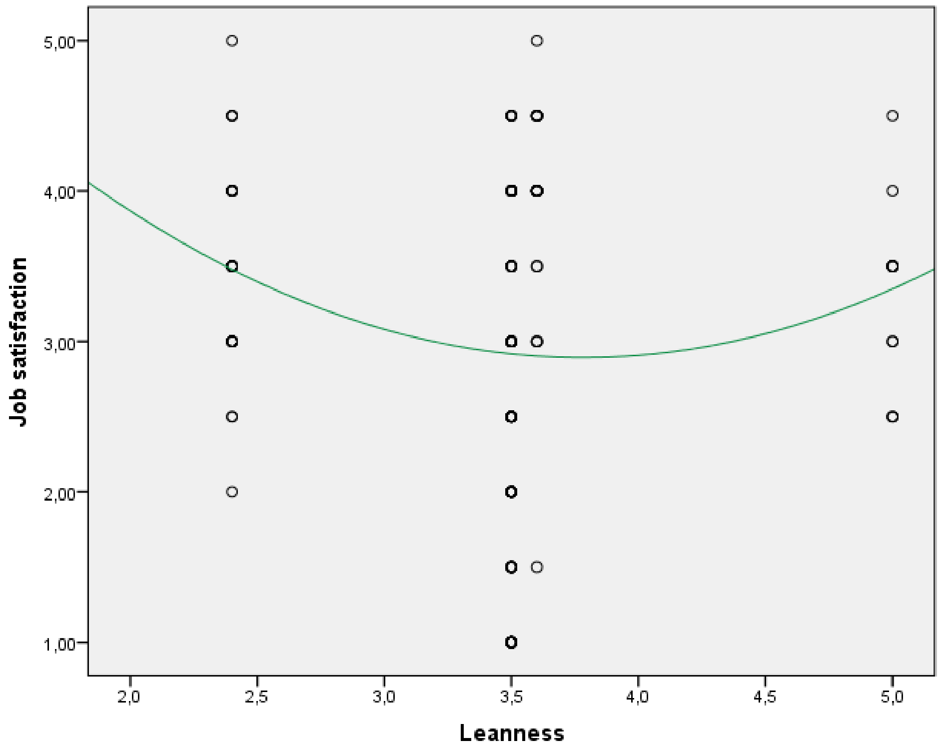


Diagram 11: Leanness and job satisfaction

Control at work

Control of decisions has also achieved a fit with a quadratic curve with the level of lean implementation *(Diagram 12)* (*F*=10, df=176, *p*=0.000, R square=10%, adjusted R square=9.3%).

At low levels of lean implementation control of decisions is high. At a middle level of implementation control of decisions is dropping to the lower point to increase over the full implementation. The sample size again limits generalisations of the results.

Table 115: Explanatory model for Control of decisions

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	6.465	1.373		4.709	.000	3.756	9.175
	Leanness	-2.657	.765	-1.564	-3.474	.001	-4.167	-1.147
	leansqr	.412	.106	1.747	3.879	.000	.202	,621

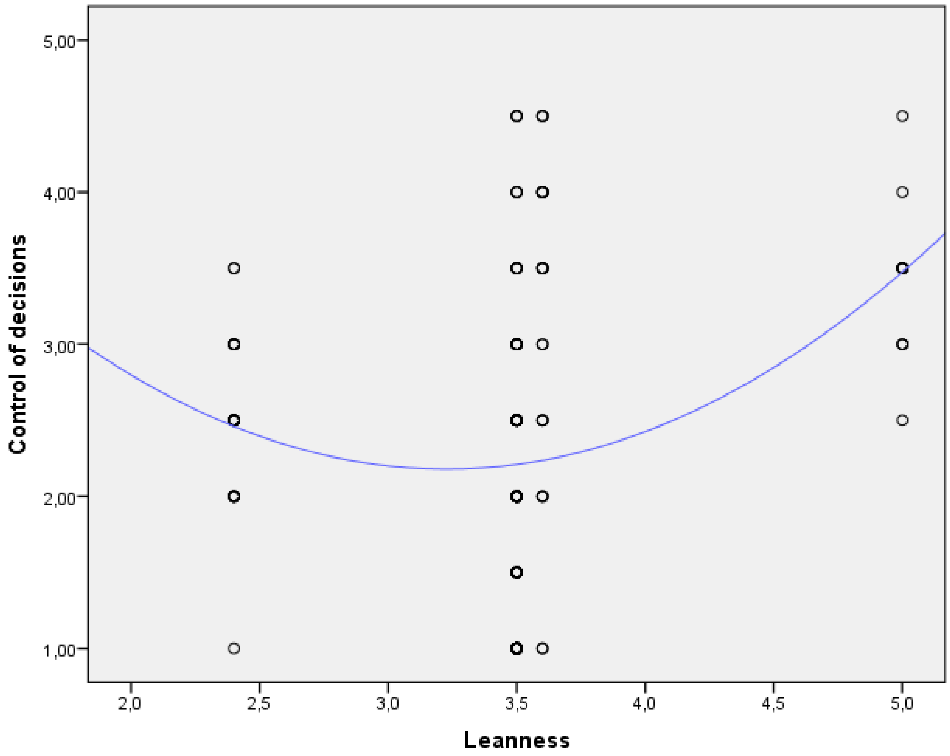


Diagram 12: Leanness and control of decisions

Control of work pacing fits a quadratic curve with a tendency to increase with lean implementation *(Diagram 13)* (*F*=5.91, df=179, *p*=0.003, R square=6.3%, adjusted R square=5.2%).

Table 116: Explanatory model for Control of work pacing

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	3.194	1.385		2.307	.022	.462	5.927
	Leanness	-.484	.773	-.285	-.625	.532	-2.010	1.042
	leansqr	,124	,108	,528	1,157	,249	-,088	,337

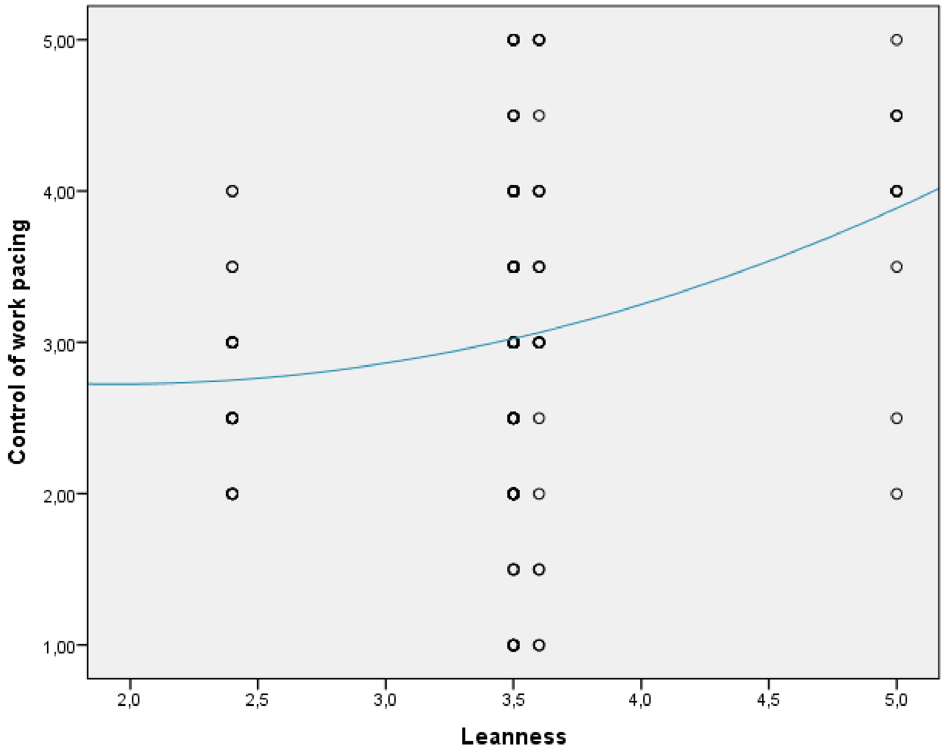


Diagram 13: Leanness and control of work pacing

Empowerment

Empowerment fits a quadratic curve *(Diagram 14)* similar to the job satisfaction curve. (F=23.11, df=169, p=0.000, R square=21.7%, R square adjusted=20.7%).

Table 117: Explanatory model for Empowerment

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	14.763	1.761		8.385	.000	11.287	18.240
	Leanness	-6.644	.982	-2.922	-6.764	.000	-8.583	-4.705
	leansqr	.895	.136	2.837	6.569	.000	.626	1.164

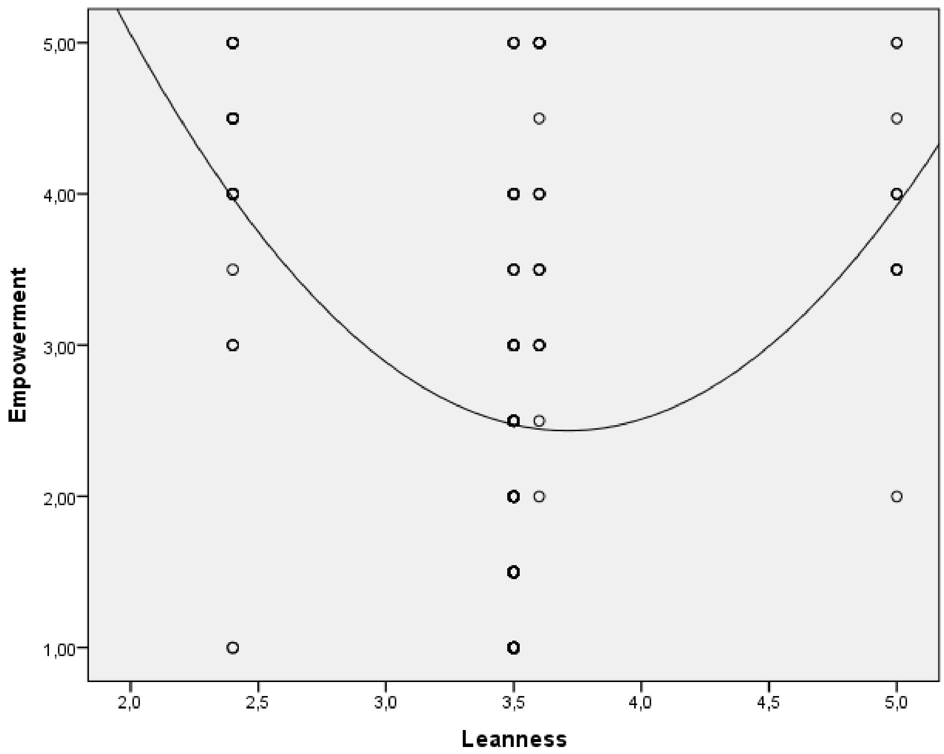


Diagram 14: Leanness and empowerment

Table 118: Summary of findings for lean level effects

Hypothesis 4:	Rejected/ Lean implementation level has no linear relation to stress – It fits a quadratic curve
Hypothesis 5:	Rejected/ Lean implementation level has no linear relation to quantitative demands

All results are consistent with Conti et al. findings. Conti et al. (2006) quotes Koenigsaecker (2000) who identifies three stages during lean implementation. The first period that lasts the first two years is ‘anti-change’, then a stabilization period in the third and fourth years after implementation and beyond that when change becomes the norm and ‘pride’ in lean accomplishments develops. However Bruno & Jordan (2002) when assessed employees' attitudes 8 years after lean implementation in automotive industry revealed that "as workers gained more experience in lean environment their positive estimations declined". Also Lewchuk and Robertson (1996) reported highest job demands in plants with full lean implementation compared to partial implementation.

During the interviews in the beverage company workers acknowledged their initial resistance to change and suspiciousness of standardization at the stage where the company was heading for advanced lean implementation. Workers felt threatened by deskilling because of the application of extreme standardization practices and considered them waste of time. Moreover, there are contradictions between management understanding of lean implementation and its potential profits between sectors, companies and even within companies. In the beverage company the lean coordinator and the safety engineer had different views on the benefits of particular lean practices. For example application of the 5S (sort, set in order, shine and inspect, standardize and sustain) system was considered by the management to have reduced movement and manual handling. The safety engineer had the opposite opinion since order and shine had removed parts from the proximity of the assembly line. Actually manual handling had increased.

However, it seems that in advanced lean implementation some positive aspects of lean - such as predictable work flow, low incidence of disturbances in production, control of decisions -, which act as buffers to stress; could start to take place. One critical aspect for low levels of stress in the company with the advanced lean implementation of the sample (Electronics Company) could be the 'no lay-offs for lean' commitment that was explained by the management during the interviews. Job stability was also identified as an important factor for reduced stress in the a posteriori interviews (after reaching advanced lean implementation) with workers in the beverage company. The lifelong employment promise was identified as critical for the success of lean implementation by Ichniowski & Shaw (1997). Pfeffer (1998) considered employment security a key to success of lean production. Seppola & Klemola (2004) also reported that low job security predicts stress.

Finally participation in continuous improvement programs in the beverage company (in its advanced lean implementation stage) was neither obligatory nor standardised. Workers had motivation (even symbolic) to produce new ideas. Moreover workers had ownership of their improvement ideas and did not feel exploited. Salvendy (1997) warned about the adverse effects of enforced participation in quality circles.

One other possible explanation for the reduced stress in advanced lean implementation is the "learning organization" effect. Companies learn from their mistakes when applying lean production. If a lean practice doesn't fit to the company; management does not abandon it but it's not so strict in its application. Therefore stress is alleviated. Such an example was found in the beverage company in its advanced lean implementation level. Kaizen and improvement ideas were applied but quantitative targets (2 Kaizen and 16 ideas per month) could not be satisfied. Workers were stressed to come up with new ideas every month. After communication with the lean officer of the mother company it was decided that since performance targets were met there was no need to follow specific targets for Kaizen and improvement ideas.

In conclusion it is not the level of lean implementation that directly influences psychosocial factors and stress but the type of lean practices applied (intensification practices) and ineffective organizational policies (lack of support to alleviate resistance to change, lack of control at work and actual worker participation, job insecurity, organisational learning). When job support and control were high combined with motivation and job security even in nominal advanced lean implementation companies; stress was reported low. On the contrary at mature stages of lean implementation (for example in the call centres), work intensifies but none or few of the moderating factors are in operation.

6. DISCUSSION

6.1 INITIAL PURPOSE OF THE STUDY

The initial purpose of the study was to investigate production optimization systems such as lean production and identify their effects to workers. The study examined the relationship between lean practices and positive effects as well as job stress and work related musculoskeletal disorders. The thesis comprises an extended literature survey and a field study in the manufacturing and the services sector applying lean production.

6.2 LITERATURE REVIEW

The literature review covered papers published the last 20 years investigating lean production effects. The majority of the studies were conducted in the automotive industry (most important studies: Adler et al, 1997, Berggren et al, 1991, Bruno & Jordan, 2002, Brenner et al, 2004, Parker, 2003, Parker & Sprigg, 1998). That was expected since lean production was originated and flourished in this industry. The rest of the studies were carried out in other manufacturing sectors and the services. Lean production is increasingly becoming a paradigm for the service sector (health care, call centres, etc). Studies comparing the effects of lean implementation between different manufacturing sectors were identified. However there was no study publicly available comparing manufacturing and service sectors.

There was evidence for the negative impact of lean production on job characteristics that can lead to job stress and musculoskeletal disorders. Also direct effects were recorded (increased job strain and MSD symptoms). The most negative outcomes were found in the earlier studies in the automotive industry. Lean practices associated with mental and musculoskeletal effects are primarily Just in Time practices (Brenner et al, 2004, Conti et al, 2006), standardization (Klein, 1991, Sprigg & Jackson, 2006), waste reduction (Berggren et al, 1991, Schouteten & Benders, 2004, Lewchuk & Robertson, 1996, Seppala and Klemola, 2004, Graham, 1995), working overtime (Berggren, 1993, Conti et al, 2006, Robertdon et al., 1993) and quality circles (Brenner et al, 2004, Bruno & Jordan, 2002).

The mechanism of lean effects is rather complex. Waste reduction and JIT can reduce cycle time and bring about intensification of work. Quality circles, continuous improvement ideas and defect control may also exert pressure to the workers. Time pressure can simultaneously activate mechanical and psychosocial risk factors.

Examples of mixed and even positive effects were also found in the literature. There is rhetoric that lean production can benefit workers through empowerment and job control. However discrepancies were found in the literature between theory and practice.

Lean production has a positive effect on occupational safety. Specific lean policies such as standardization and mistake proofing can improve safety. High performance systems increased perceived safety climate at the organizations and reduced safety incidents. However some JIT practices can bypass safety. Intensified trends in transport sector were often at the expense of safety (Stoop & Thissen, 1997).

An examination is also made of the changing focus of studies investigating the consequences of lean production over the 20-year period. The trend analysis in time identified three main periods for the studies: one in the nineties, the other in the beginning of the twenty first century and finally recent studies. Inevitably nineties were the period where lean production aroused great interest in organizations outside Japan and became fashionable in the US automotive industry. Therefore inevitably studies concentrated on this sector investigating musculoskeletal disorders and stress. The majority of the findings were negative. At the second period studies examined also other manufacturing sectors implementing lean production since this was the trend at that time in Europe. Increased workload was identified but not always linked to stress. The recent studies of the last decate included more manufacturing sectors and expanded its focus to services that began to experiment in lean production. The results were mixed and the effects were depending on the sector, the social context and the management style in lean application.

Indeed, there is no universal definition, understanding and application of lean production (Pettersen, 2009). Its core principles are waste reduction, quality improvement, defect control and Just in Time delivery. Lewis emphasized the need "..to distinguish between the lean concept as an output and the ambiguous process whereby an operation becomes lean" (Lewis, 2000, page 961). This ambiguity has an inevitable impact on investigating lean outputs and interpreting the effects to working conditions and workers' health. Conti et al (2006) in a large scale study examined leanness' direct association with job stress and found a non linear relation. Nevertheless some lean characteristics found to be associated to job stress and musculoskeletal disorders such as JIT are core practices of this system.

An interaction model is developed to propose a pathway from lean production characteristics to musculoskeletal and psychosocial risk factors and also positive outcomes. Lean characteristics were linked to the relevant stress and musculoskeletal models. The stress models and mechanisms of demands–recourses-control imbalance, effort–reward imbalance, role over load, psychological demand, social support are applicable in lean production. The mechanical exposure model for MSDs development included risk factors such as high repetitiveness, lack of recovery, awkward postures and manual material handling. Mechanical and psychosocial exposure model for MSDs were also applicable in lean production. What is apparent from this model is that lean production has a greater impact on work-related stress compared to musculoskeletal disorders. That is because lean characteristics influence concurrently a number of psychosocial risk factors that have a direct effect on workers.

The conclusions of the literature review re-defined the field study and the research hypotheses were formulated. The field study aimed at contributing to the knowledge gap on lean practices implementation in non-automotive manufacturing and services sectors that will dominate in the future. It particularly aimed at investigating potential consequences of such systems on psychosocial factors and musculoskeletal disorders. Effects on occupational safety were not the subject of the study.

The effects of lean characteristics to job stress were based on the Job Demand/Control Stress Model (Karasek, 1979). This study acknowledges the difficulty; already recognised by other researchers; of having "clear cut" lean companies and investigated also the level of lean implementation for each case study. Thus the direct relationship between job stress, job demands and "leanness" was analysed. The relationship between

MSDs and lean characteristics such as quantitative demands and performance monitoring was examined.

Finally there was the opportunity to compare psychosocial environment and health outcomes between lean manufacturing and services. The field study tested also the applicability of the interaction model in manufacturing and service sectors.
The study employs psychosocial and musculoskeletal disorders questionnaires, interviews with the management and workers and site tours.

6.3 Limitations of the field study

The field study had several limitations. One limitation was that it was a cross sectional study without a non-lean control group in the cases studies. This was not possible in the quantitative survey. However, effects of different levels of lean application were reported. Also comparative qualitative data have filled the knowledge gap as much as was feasible.

Moreover the sample of manufacturers was not random because the choices were made based on the companies' willingness to participate. Thus the selection might have been biased. This was not valid for the services sample that was fairly representative.

Administration of questionnaires procedure in general was far more controlled by the management in manufacturing compared to the situation in call centres. This might had an effect on the representation of the replies received and the final results in manufacturing. Influence was reduced since conclusions were crosschecked and enriched with qualitative data from the interviews.

For psychosocial research and MSD symptoms self-reported questionnaires were employed as is usually the case in this type of research. Observations and interviews completed the picture.

The musculoskeletal symptoms questionnaire was only accepted by one company in manufacturing. Therefore in the comparison of this variable between sectors, the data from the services sector were dominant.

National culture could be a potential confounding factor because one company was located in UK and the others in Greece. Earlier studies have found no cultural barrier for lean implementation (Womack et al, 1990). In their study, independently from the country, the plants which performed best in lean implementation were those with a strong Japanese management presence. Organisational culture had a stronger impact compared to the national one.

Recent studies (Abrahamsson & Isaksson, 2012, Kulla et al, 2014) have found correlations with lean implementation and national culture the latter measured with Hofstede's dimensions (Hofstede, 1980). In particular; high Uncertainty Avoidance Index (UAI)[7] has a positive correlation with lean production. This dimension allows standardisation that is typical in lean production. Also high Power Distance Index (PDI)[8] has a negative impact to lean production since lean teams have a less hierarchical structure. Cultures with high PDI are tolerant to inequalities and apply strict hierarchies.

On the Hofstede's culture dimension data matrix for different countries, Greece has higher UAI and PDI compared to UK. In theory that means that national culture impact on lean implementation in Greece could have been a lower resistance to lean standardisation but potential problems in team development with less hierarchical levels compared to lean implementation in UK. National culture differences can affect the approach and speed of change in lean implementation. However it was not controlled in this study.

6.4 Conclusions of the field study

The results of the field study are based on 353 responses in psychosocial and MSD questionnaires in both sectors and qualitative data from the interviews and observations. The QPSNordic 34+ Psychosocial questionnaire and the Nordic musculoskeletal questionnaire were employed in the field study.

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[7] Uncertainty avoidance deals with a society's tolerance for uncertainty and ambiguity.

[8] Power distance is the extent to which the less powerful members of organizations and institutions (like the family) accept and expect that power is distributed unequally.

The values of the psychosocial questionnaire in the sample were compared to the normative values (Lindstrom, 2000). The job demand characteristics were lower in both sectors with the exception of learning demands in manufacturing that were higher than the normative values. However job control was lower in call centres but higher in manufacturing. Support from superior and coworkers were higher in both sectors. Empowerment was lower in call centres but higher in manufacturing. Finally stress in call centres was higher compared to the normative values where in manufacturing it was the same. Job satisfaction has higher values in both sectors but for manufacturing it is considerably higher.

Table 119: Comparison of psychosocial factors with normative values between sectors

Psychosocial factors	**Values compared to normative**	
	Services	**Manufacturing**
Quantitative demands	<	<
Learning demands	<	>
Control at work	<	>
Job support	>	>
Empowerment	<	>
Stress	>	-
Job satisfaction	>	>

Job demand variables are partly associated to stress in the lean case studies. Hypothesis 1 –quantitative demands- was supported in call centres and rejected in manufacturing. This result was consistent with a study on lean effects in call centres (Sprigg & Jackson, 2006) and in disagreement with earlier studies in manufacturing industries (Conti et al, 2006, Seppola & Klemola 2004, etc.). Production pressure was increased by lean implementation in the manufacturing case study. However stress was not explained by that, in line with the Jackson & Martin (1996) study.

Hypothesis 2 was about performance monitoring and its relation to stress. Although monitoring is a clear lean characteristic dominant in call centres it was rejected in both sectors. Workers didn’t feel stressed directly by the monitoring as such but by the lack of information and involvement on the exact criteria it was based on.

Some job control variables (Hypothesis 3) are related to stress in both sectors. These were control of work pacing in call centres and positive challenges in manufacturing. Job control and support characteristics were significantly higher in manufacturing. This can probably explain the non association of job demands to stress in this group.
Job stress was reported lower in manufacturing in comparison to call centres but the difference was not significant. However job satisfaction was significantly higher in manufacturing. Manufacturing workers enjoyed job security from their companies and better balance of effort and reword.

A large number of employees in call centres reported often MSD symptoms in the neck, the shoulders, wrists/hands, upper and lower back (a 23%-57% depending on the symptoms). MSD symptoms in manufacturing were significantly lower. Quantitative demands did not predict MSD symptoms in call centres or manufacturing (Hypothesis 6). This study finding shows a difference from the findings of previous studies on lean environments that connected high workload with increased MSD symptoms of upper limbs primarily (Adler et al, 1997, Berggren et al, 1991, Graham, 1995, Lloyd and James, 2008, Mehri, 2005).

Information on performance monitoring was only associated to neck symptoms in manufacturing (Hypothesis 7: Performance monitoring and MSD symptoms).

Stress had a positive relation to MSDs only in call centres consistent with psychosocial exposure theories (Hypothesis 8).

This study can contribute to the lean effects theory by examining the validity of an interaction model on mental and musculoskeletal effects and its applicability to services and manufacturing. It also specified the generally described lean characteristics in the model.

The interaction model/pathway had a better fit in call centres where several links of lean characteristics to stress and MSD symptoms were active. Performance monitoring connection to stress was added to the model. Although it did not explain significantly stress in the statistical analysis it was considered to be important due to relevant information coming from the interviews. The only modifier to stress applicable was control of work pacing.

In the manufacturing sector fewer connections of the lean characteristics to stressors were applicable. However although at the initial model it was predicted that waste reduction would reduce physical exposure like manual handling in was not the case. Existing modifiers of stress were confirmed (Job control and job support) and a new one was added. That was information for performance monitoring for MSD symptoms.

Psychosocial environment and MSD symptoms reports seem to be better in manufacturing compared to services sector (call centres) implementing lean practices. However, these findings should be treated with caution because of the small size of the sample from the manufacturing sector.

Finally the main research question of the field study was to investigate direct relation ship between job demands & job stress and the level of lean implementation (Hypothesis 4 & 5). The investigation was made to the total sample of the companies in both sectors. The lean levels varied from fair to advanced lean implementation with a mean score of 3.62.

No linear relation was found for stress or for job characteristics. The best fit was achieved with quadratic curves. This is consistent with Conti et al study (2006). The hypothesis assumed that increases in lean implementation will increase job stress accordingly. This happened at low and middle levels of lean implementation. Stress actually decreased with advanced implementation.

This can be explained by several reasons. One is the initial resistance of workers to change in the first years of lean application (Koenigsaecker, 2000). This is contrary to Bruno & Jordan (2002) argument that with the lean experience workers instead of take pride of lean achievements they change from their initial positive estimations. In this study ‘no lay-offs for lean’ commitment by some companies was important for lean concept acceptance. Lewis (2000) in a critical study on lean application reported that some lean companies only managed to improve their financial performance by reducing their staff in the name of waste reduction.

Another explanation might be that some modifiers to stress like job control and management support are activated or increased in mature lean organizations. This is not necessarily true according to the lean theory. “Lean production is inherently a low job control environment” (Conti et al, 2000, p1032). As stated in the literature review standardization minimizes job control and autonomy. On the other hand job support and even limited autonomy, identified as modifiers to stress in the literature, don’t have to be introduced in advanced lean implementation. No doubt control of decisions can be given to production groups after lean training and practice. What is also apparent is that some positive effects like low incidence of disturbances in production happens in mature lean systems.

However what seems to be the most critical of all is the management decisions on which lean practices to implement, when, how and to what extend. Lewis (2000) illustrated in his cases that there is a great deal of variation inherent in the lean initiatives and each firm follows its own, unique “lean production trajectory” (p 975). Organisational culture is fairly important in lean application. Organisation learning in advanced lean implementation can make fine adjustments to the extent a lean tool is used and avoid adverse effects on the health and safety of workers. In this study the beverage company in its lean advanced form customised lean application and avoided Kaizen and improvement ideas specific targets. This could have alleviated job stress. This might also be the reason companies with high leanness report low job stress. They probably learn from their mistakes. Recently there is a debate among researchers on which is the best way to implement lean production: standardization or customisation (Abrahamson & Isaksson, 2012, Oudhuis & Tengblad, 2013). Abrahamson & Isaksson (2012) found both approaches to be effective. Customisation can overcome national cultural differences. For example Nordic employees don’t accept extreme standardization of lean production without explanation and motivation. These countries have a history of self directed teams in their production. Oudhuis & Tengblad, (2013) identified the so called "contextual sensitivity" that should be applied in lean implementation taking into account company specifics such as production volume, automation and other characteristics. According to the authors this approach could allow sociotechnical characteristics such as self directed teams in lean environments. The author of this thesis believes that customization and contextual sensitivity towards less strict lean approaches can be also beneficial for the workers well being.

Moreover social relations are important. Active worker participation can influence the process to their benefit particularly in the changeover phase (Adler et al, 1997, Hampson, 1999, Parker, 2003). Forza (1996) found higher worker' consultation on proposed changes at work in lean plants than traditional ones. In this field study continuous improvement suggestions were not obligatory. Moreover workers had ownership of their improvement ideas and did not feel exploited. Worker participation in process improvement had also a negative relation to stress in Conti et al study.

Finally, other non-lean trends over the period of research could have influenced the results. Special legislation on stress or prevention of musculoskeletal disorders could have rendered companies more sensitive, performing better in OSH independently of their production method. However, there was no new legislation on these topics immediately before or during the research period. The last relevant European Directives; Framework Directive 89/391 that sets the general prevention framework for occupational risks which does not have specific provisions for stress or upper limbs musculoskeletal disorders prevention and Manual Handling of Loads Directive 397/1994 for preventing back injury; were introduced and transposed to national legislation in Greece and UK more than a decade before the study. OSH legislation could have not influenced in any way the results of the study. However HSE, the labour inspectorate in UK, had introduced a non-compulsory management standards approach to stress with specific questionnaire and guidance; before and during the present study. In conclusion the company in UK could have been more aware of stress prevention but not necessarily more effective in preventing it.

Automation can reduce ergonomic and psychosocial stressors. Womack et al (1990) had predicted that automation will move rapidly in future lean companies. However the same authors in the afterword of a later version of their book (2007) acknowledged that this bold prognosis was pure dreaming. Manual work was still prevalent in automotive industry and other lean industries. «In practice there has been very little additional automation of final assembly since 1990 and the same holds for component assembly», (Womack et al, 2007, p. 292). In this study the beverage company was fully automated and workers intervened only for changing dies in the machines and in case of trouble-shouting. Ergonomic stressors with the exception of manual handling that was present could have been lower in this company compared to the other companies in the sample. This might have had an effect on MSD symptoms results. The beverage company only replied to the MSD questionnaire from the manufacturing cluster and the symptoms reported were lower compared to the ones reported in the call centres.

6.5 LEARNING FROM THE FIELD STUDY

To summarise the main learning from the study:

- Lean production can bring intensification under certain circumstances. Particularly in the case of the call centres quantitative and learning demands were increased and statistically explained job stress. However in manufacturing only learning demands increased. Rigid and rule-based climate due to standardization explained stress in the manufacturing sector.

- The Karasek Job Demand – Control stress model seems to be applicable in this small scale study. In a large scale study (Conti et al, 2006) the fit of this model to lean production was questioned. "Job stress responses to job demand and job support practices in lean production were much stronger than those for job control".

- The interaction model/pathway from lean characteristics to stress and MSDs is partly confirmed in this sample although further testing is needed.

- Some modifiers to job stress and MSD development were identified in lean implementation. Westgaard & Winkel, (2011) in an extended review paper on rationalization systems, reported modifiers' influence on lean effects. Genuine autonomous groups, management support, worker participation and consultation during lean production were among them. Job security was also identified as modifier by researchers (Ichniowski & Shaw, 1997, Seppola & Klemola, 2004, Pfeffer, 1998). This study confirmed existing modifiers such as job control, superior support, positive challenges, empowerment and job security present mainly in manufacturing. It further suggested information and effective consultation (comments actually taken into account) during performance monitoring as a modifier to job stress and MSD stressors.

- Lean implementation level doesn't have a linear relation to job stress and other job characteristics. The relationship is far more complicated. Suggestions for organizational learning effect in mature lean systems require further research.

7. CONCLUSIONS

This thesis investigates production optimisation systems such as lean production and their consequences for the health and safety of workers. In particular it examines potential positive effects and adverse effects on stress and musculoskeletal disorders (MSDs).

An extended literature review revealed that there are discrepancies between theory and practice of lean application. High standardization of processes in lean production prevents autonomy of workers that is limited or closely monitored by the management. Promised empowerment depends on the social relations of the company. However lean implementation is uneven between countries, sectors and companies.

A trend analysis in time over the last 20 years examined the changing focus of studies investigating the consequences of lean production. During the nineties, the studies investigating lean effects, focused on the automotive industry and MSD symptoms and job stress. At the end of that decade and beginning of 2000, there was a shift in focus to investigate psychosocial factors and stress in other manufacturing sectors following the worldwide lean implementation trend. The recent studies in the last decade of the 21st century investigated lean effects for job stress in manufacturing and services sectors. 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.

The literature review results indicate that standardisation, mistake proofing and similar lean practices can improve occupational safety. High performance systems that apply lean approaches had positive relations with perceived safety culture. However, the effects of lean production on occupational safety were not in the scope of the field study.

The literature review concluded that the adverse effects on the health and safety of workers are associated with some lean practices. Particularly Just in Time can cause intensification of work that is associated with both mechanical and psychosocial exposure that can lead to MSDs and stress. This was partly confirmed by the field study.

A pathway between lean characteristics and musculoskeletal and psychosocial risk factors was developed based on the literature review. The proposed model made contributions to our understanding of the link between lean production systems and stress, MSD symptoms and positive effects as well. Several lean practices aimed at maximising efficiency such as waste reduction, Just in Time and standardised operating procedures can intensify work and can trigger stress and musculoskeletal disorders development according to this model. What is apparent from this interaction model is that lean production has a greater impact on work-related stress compared to musculoskeletal disorders. That is because lean characteristics influence concurrently a number of psychosocial risk factors that have a direct effect on workers. However, modifiers of these effects are also present in this model. Lean autonomous groups can provide, if operated properly, control at work and social support for the workers. Moreover, reduction of waste can remove some physical stressors like manual transportation and similar hazardous movements that can contribute to MSD development. Having said that, it has to be acknowledged that 'the time pressure variable' is the most critical of all in lean implementation since it can impact all the stressors of the workers.

The interaction model was partly supported by the evidence from the field study. However, the results from the call centres better fitted the model than the results from manufacturing. This does not necessarily mean that lean application in the service sector triggers more stressors and subsequent more health effects on workers compared to manufacturing. It was not the stressors that were higher in the call centres' sample but a significant number of job support and control characteristics that were reported as being higher in the manufacturing sample of the study.

The research hypotheses were tested separately for each sector. Similarities and differences for lean effects on stress and MSDs were reported. Performance monitoring was not a significant factor for predicting stress in call centres or the manufacturing sector. However, performance monitoring, a critical lean characteristic in call centres, was as expected considerably higher in call centres. Similarly job stress was associated with lower control at work in lean environments in both sectors. Quantitative demands were not predictors of MSD symptoms in the call centres or the manufacturing sector. Only pain in the lower and upper back was associated with quantitative demands in call centres.

Quantitative demands were predictors of job stress in call centres but not in lean manufacturing. Differences in job demands between sectors were not significant with the exception of learning demands that were higher in manufacturing. Stress was a predictor of MSD symptoms in the service sector but that was not the case in manufacturing. Although performance monitoring was not a predictor of any of the MSD symptoms in call centres, information for workers on performance monitoring was a mediator to neck pain in the manufacturing sector.

Stress was not significantly different among sectors but job satisfaction was higher in manufacturing. Call centre operators reported significantly more often pain in the neck, the shoulders, wrists/hands, upper and lower back in the last 12 months.

The level of lean implementation had no linear relation to stress or quantitative demands for the total sample in both sectors. The best fit was achieved with quadratic curves. At low levels of lean implementation stress was increasing. At a middle level of implementation stress reached a peak after which, with advanced implementation, it decreased. This is consistent with earlier study findings. Job satisfaction, control at work and empowerment followed a reverse curve.

The study demonstrates that it is not so much the level of lean implementation that is important for the health & safety effects but the lean characteristics that are employed. Characteristics linked to JIT can be critical and can be associated with increased job demands and in some cases increased stress and MSD symptoms. Moreover it is the social context (management mentality and actual workers' participation) in lean application that is crucial for the implications of lean work to health. Organisational learning can lead to customizing lean practices to less strict approaches that then alleviate job stress.

The strong unwillingness of many of the companies contacted to participate in the study, some times right after an initial acceptance and endorsement of the questionnaires, can lead to a further conclusion. Lean production is a fragile system in organizations that are in a subtle balance. Companies are not willing to disturb this balance and potentially trigger a debate on the issues.

Alternatives to lean systems were also reviewed. High Performance System, an evolution of lean production, is also associated with intensification of work and job stress. Sociotechical systems as well as humanised production paradigms of 20th century - such as the Uddevalla and Saturn plants- were recalled as a revival effort for democratising working conditions. However 'nominal' production systems cannot by definition be harmful or democratic and low risk. Certainly the philosophy of a production system and its core aims differentiate the concepts between them (Human centered vs High Performance). But implementation specifics also characterize the systems and may trigger health effects on the workers or alleviate them.

Recently researchers investigated alternative systems that are defined as "sustainable" in the literature. The notion of sustainable systems is borrowed from ecology. The term "Sustainable development" was first used in the Brundtland Commission Report, entitled "Our Common Future (Commission, 1987) and later adopted by the United Nations in the following way: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

«Work intensity refers to the consumption of human resources in work organizations while the sustainable work systems concept presents a vision for the future competitive organizations in which human resources are regenerated and allowed to grow», (Docherty et al, 2002). «According to the structuration theory approach (Giddens, 1984), intensity is basically caused by a misfit or imbalance of high demands and prescriptions of work on one hand and inadequately developed rules and resources in the collective acting of the working on the other. In order to achieve the characteristics of sustainable work systems, a new balance of reasonable demands and available resources has to be found by redescribing work on a higher level», (Docherty et al, 2002).

Several strategies could lead to sustainable systems. Group-based self-organization seems to be the cornerstone of a more sustainable work system. The most important aspect of group self-organisation is not autonomy in the classical sense but the extent of the resources that are at the disposal of the groups and whether the groups really establish new group-oriented working rules like mutual support or consensual decision making. Another important aspect of sustainability in the organization of group work is democratic procedures for instance on electing the group spokesperson. Similarities can be found between sustainable systems and sociotechnical ones. Sisson et al (1997) compared teams according to the Scandinavian model, which resembles sociotechnical teamwork, and the lean production model. The differences between “Volvoism” compared to “Toyotism”, were the voluntary character of participation in teams, the selection of group members and leader by the groups and not by the management, the complexity of the tasks over simplicity and large autonomy over narrow one. Recently some researchers suggested that implementing both lean elements and elements of sociotechical systems is feasible, can lead to better plant performance and work enrichment (Dabhilkar & Ahlstrom, 2012, Oudhuis & Tengblad, 2013).

Last but not least, a critical parameter of a more sustainable work organization is the question of how work characteristics (workloads, staffing levels and other targets or rates) are set. The new system gives this power directly to the group (Docherty et al, 2002).

The new paradigm of sustainable work organizations is not easy to pursue. Moreover practical cases from enterprises applying such models that could provide insights on the removal of existing barriers are scarce. On the other hand the development of sustainable work systems is a logical part of the European debate on forms of work organization as expressed in the 1997 EU Green Paper on “Partnership for a New Organization of Work”. Also in the European Commission strategy “Europe 2020”, sustainable growth is the main target (European Commission, 2010). «If the European Union is serious about meeting the objectives in its Europe 2020 strategy, sustainable work and employment should be given high priority, as this is a pre-condition for meeting the objective of high employment» (Eurofound, 2012, page 126). Working conditions also need to improve to reach these targets. The fifth European Working Conditions Survey (Eurofound, 2012) monitored among other issues the job sustainability of European workers (ability to continue to work until retirement age). The main conclusions from the study were that autonomy, job security and social support play a positive role, whereas work intensity, physically demanding and monotonous work, and discrimination play a deterrent role for sustainability. This European vision –competitiveness and sustainable growth through reproduction of resources – could be offered as a contrast to American and Japanese experiences (Eijnatten, 2000).

With few exceptions, sustainability appears to be a new concept to ergonomics (Martin, 2013). However several researchers have investigated the role of ergonomics in implementing sustainable organizational strategies (Zink & Fischer, 2013, Ryan & Wilson, 2012). According to Wilson, «ergonomics offers a systems-based approach to the investigation and support that is necessary for the actual implementation of policy on sustainability in organizations, with an ability to consider the interactions between the wide range of interacting influences on and within any organization» (Wilson, 2000). Other researchers believe that a sociotechnical approach to ergonomics known as macroergonomics can promote socially sustainable production systems (Guimaraes, 2012).

The contributions to original knowledge of this thesis are first that it provides a trend analysis in time over the last 20 years of the consequences of lean methods for the health and safety of workers. It further suggests a pathway from lean characteristics to positive effects and to effects of stress and MSDs.

Moreover the pathway was tested in a field study where a comparison was made between the effects of lean practices’ application in services and manufacturing sectors. This is a rare study, if not the only one from known published data, that compares lean effects in manufacturing and services.

Also this study suggests organizational learning is an important aspect in lean implementation that can reduce stress by customising strict lean practices.

Two peer-reviewed publications in scientific journals were produced by this study. They are both included as appendices to this thesis.

The contribution of this thesis to practice is that it recognises buffers (modifiers) in lean effects in manufacturing and services, which are emerging lean systems. Control at work and workers' information/consultation, as well as job security were identified as modifiers. This study actually confirms modifiers already suggested by other researchers investigating lean effects. One new modifier identified in this study is information and consultation before performance monitoring.

Further research is needed to compare also other type of services with manufacturing since call centres might be an example of extreme lean implementation. This could shed light on potential new stressors or/and buffers to stress between different lean applications. More research is needed on potential modifiers for lean system effects. Also future studies could investigate the effect of national culture on lean implementation and subsequent health and safety effects.

Further investigation is needed to demonstrate whether and why in advanced lean implementation stress is reducing (preferably an in-depth qualitative study). The effect of organizational learning needs further testing.

Finally, research is needed on alternatives to intensive systems that would have better consequences for the health & safety of workers.

8. Epilogue – Is lean production the chameleon camouflage for companies?

Paraphrasing the Greek poet Kavafis in his «Ithaka», the journey into the lean world and efforts to find companies to participate to the field study- negotiations with a company lasted more than 2 years and still failed - was equally useful to the actual field study and provided valuable conclusions that benefited my research. Companies that declined felt threatened. Especially the companies that had one to two years lean production implementation were more reluctant to participate. Investigating psychosocial and other health effects could raise serious issues among workers and disturb the ‘delicate social peace’ after lean production was implemented. Workers’ concerns would find an opportunity to rise. Management had no intention to identify the roots of the problems from lean implementation and try to tackle them.

Flexible manufacturing, such as lean production, was developed to make the companies more adaptive in the global environment and responsive to clients’ requests that are constantly changing.

Most recently it was discovered by scientists that the chameleon changes its camouflage not to adapt to his environment, as was initially believed, but when it experiences fear. Organisations too can apply lean and similar high performance systems spasmodically, partially and only temporarily, out of fear that they might not survive in extremely competitive markets. It is their attempt at modernisation. That way they do not realise the power and potential of these systems on the one hand and the consequences for the workers on the other. Application of lean practices irrespectively of the sector should be a part of a gradual process to adapt to change that safeguards workers’ wellbeing and delivers its promises. Companies that «abuse» the lean systems, and the whole concept of high performance by abusing what should be its main strength, that is workers themselves, cannot remain viable.

The role of the ergonomic discipline in this transformation of work and its effects is significant. Drury (2008) attempted a redefinition of the future of work and ergonomics 45 years after Bartlett (1962). There is an increase in work intensity, a tendency to multi-skilling and increased working times. As Bartlett had predicted physical work is diminishing and cognitive work is increasing through the application of technology. However, health effects related to physical work are still a concern. The service sector is constantly increasing across Europe and is importing practices from industry to maximize efficiency and achieve cost savings.

Ergonomics has and always will have to balance job demands and well being. Apart from that ergonomics now more than ever before has the obligation to suggest work re-design that aims at sustainability for all parties.

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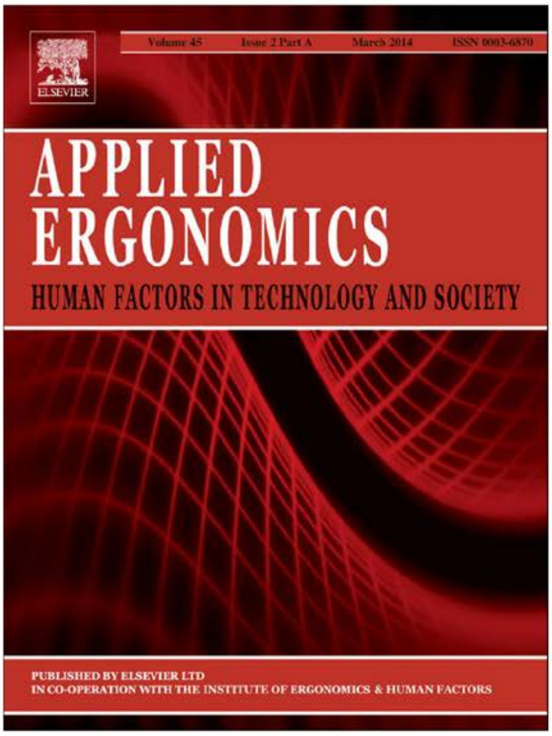
10. APPENDICES

10.1. Applied Ergonomics, 2014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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.

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

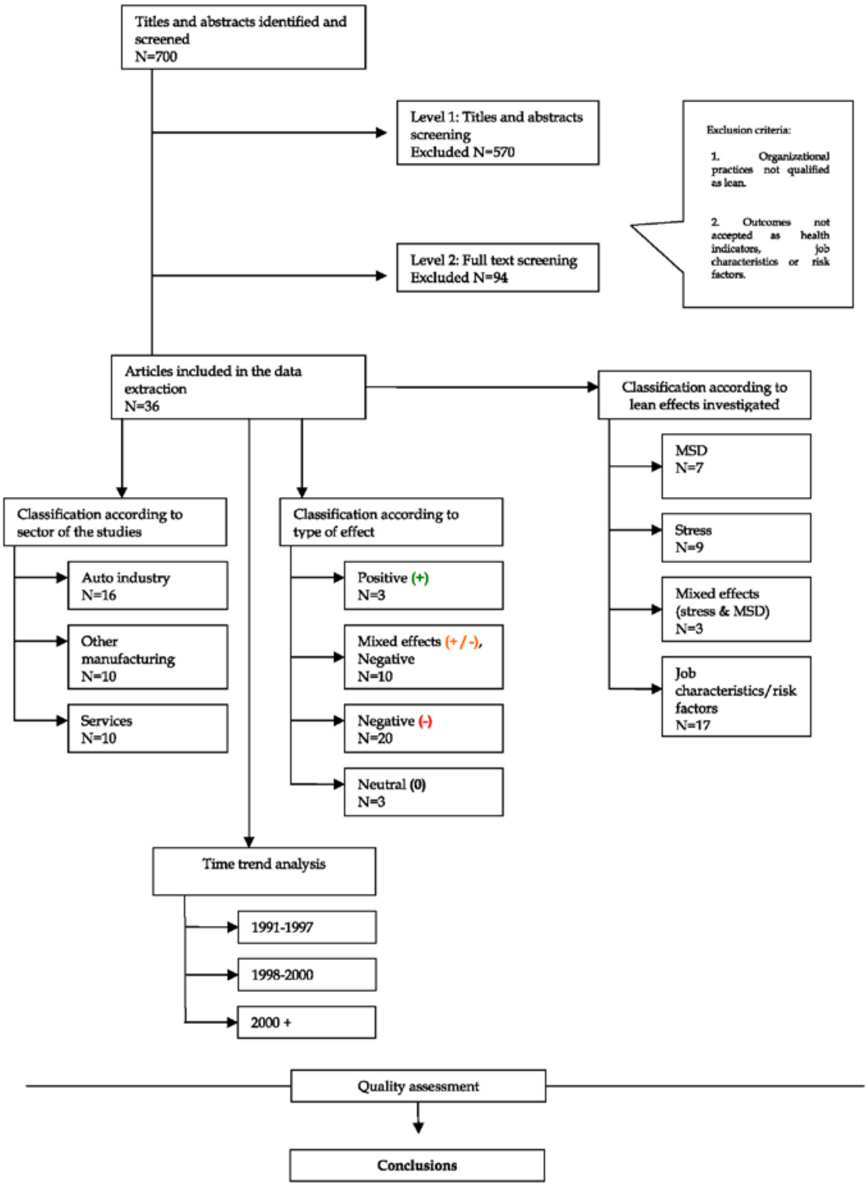

Fig. 1. Flowchart of the literature review.

There is no consensus on a definition of lean production between authors in the literature (Pettersen, 2009) but one central and agreed purpose of lean production is waste reduction. For that reason work processes are designed to eliminate waste (muda) through the process of continuous improvement (kaizen). Waste is defined as 'non-value adding' activities. Examples of 'muda' are overproduction, waiting, excess inventory, motion, defects, etc. To avoid overproduction, a 'pull' system is used where only the required material is produced (Just-in-Time approach). Ensuring quality and continuous problem solving are priority issues in lean production (Liker, 2004). TQM is a management strategy that aims at increasing quality in all organisational processes. TQM is a tool that is being used in lean production to achieve its objectives. Standardised work is also critical in lean production. Standardised work comprises three elements: takt time, work sequence (what is the best way to do the process?) and in process stock (max inventory). Takt time is the pace of production needed to meet customer demand. Takt time differs from cycle time, which is the actual time it takes to do the process. The goal of lean production is to synchronise takt time with cycle time (Pascal, 2002). Summarising the lean characteristics, lean is a concept comprising Just-in-Time practices, waste reduction, improvement strategies, defect control and standardization.

Lean production first appeared in automotive industry, was later disseminated to other manufacturing areas and recently to services, namely healthcare, telecommunications, public services and other. Oeij and Wiezer (2002) found it difficult to make clear distinctions between organisational concepts (like Taylorism, lean production and sociotechnology) and business practices that are used within such concepts as TQM and Just-in-Time systems. Hybrid forms (intermediate forms) are usually applied in other than automotive manufacturing and services and this further complicate the distinction between lean production practices and organisational forms. This problem of distinction affects the evaluation of possible effects that work organisation and particularly lean practices have on working conditions.

4. Musculoskeletal and psychosocial risks

This review examines the effects of lean practices on musculoskeletal disorders, stress and associated risk factors. Work-related Musculoskeletal Disorders (MSD) cover a wide range of inflammatory and degenerative diseases of the locomotor system (Buckle and David, 2000). Musculoskeletal disorders have a multifactorial aetiology. Different groups of risk factors include physical and mechanical factors, organisational and psychosocial factors. Individual and personal factors may contribute to the genesis of MSDs. Examples of risk factors are repetitive handling at high frequency, awkward and static postures, force exertion, vibration, etc.

Although automation systems have been introduced and reduction of strenuous work has been achieved with the help of ergonomic interventions in the last decades, there is an increasing trend towards more physical risks and related musculoskeletal disorders. Musculoskeletal disorders are among the six most commonly recognized occupational diseases in Europe. The most frequent occupational disease is hand or wrist tenosynovitis followed by epicondylitis of the elbow and carpal tunnel syndrome comes sixth (Eurostat, 2004).

Work-related psychosocial risks concern aspects of the design and management of work and its social and organisational contexts that have the potential for causing psychological or physical harm (Leka et al., 2003). Psychosocial risks are job demands, time pressure, low job control, social relations with superiors and colleagues, job insecurity, etc. These risks are linked to work-related stress, violence and bullying. Stress is related to sleep disorders, cardiovascular diseases, depression and other disorders. A study in Germany found that high job demands (expert rated) were associated with major depression (Rau et al., 2010). A meta-analysis of 79 studies reporting cross sectional and longitudinal relationships between physical symptoms and various occupational stressors studies found significant relationships between job stressors and gastrointestinal problems and sleep disturbances (Nixon et al., 2011). However, researchers have reported the effects of buffers in high demand environments. Dalgard et al. (2009) tested the Demand Control model and reported a strong 'buffering effect' for the interaction between demands and control. There was almost no increase in psychological distress when high job demands were combined with high control.

The HSE estimated in 1996 that in the UK stress-related illness is responsible for the loss of 6.5 million working days each year, costing employers around GB£370 million and society as a whole as much as GB£3.75 billion (HSE, 1999). In 2004/2005, an estimated half a million people in Great Britain believed they were suffering from stress, depression or anxiety that was caused or made worse by their current or past work. An estimated 12.8 million working days were subsequently lost (Jones et al., 2003). In less than 10 years the estimated number of days lost due to stress has more than doubled in UK.

The European Commission in its strategy on health and safety at work 2007–2012 acknowledges the emerging problems of musculoskeletal complaints and psychosocial risks – it calls them new risks – that require a new focus and even legislative action. The Community Strategy also emphasises the importance of research into new and emerging risks for designing preventive solutions (Koukoulaki, 2010).

To be able to plan successful preventive interventions for musculoskeletal and psychosocial risks and ensure sustainable work organisations, in a 'rationalisation era', the mechanisms by which new production systems have an impact on health need to be fully understood. To this end the effects of lean practices are discussed in the results section under the following headings

i. Studies that have evaluated whether the promised benefits of lean production for the workforce have been obtained. The studies reported are not part of the systematic review.
ii. Studies of the effects of lean production on health and safety issues, first the relation to musculoskeletal disorders and second the effects on stress at work. This section reports the results of the systematic review of 36 studies.

5. Results

5.1. Studies appraising the 'benefits' of lean production

Womack et al. (1990) in what many regard as the notorious book 'The machine that changed the world' argued that lean production is not only the most efficient system for manufacturing cars but is the one best way of organising all kinds of industrial production, featuring both dramatic increases in productivity and qualitative improvements in working conditions. The alleged benefits of lean production are job autonomy, worker participation, empowerment, job enlargement, etc. However researchers have questioned the promises of lean production.

Klein (1989) warned against over-promising autonomy when introducing lean production. Murakami (1994) observed that while with teamwork more 'autonomy' is given to the shopfloor, this 'autonomy' remains closely monitored and controlled by the company itself. There seems to be a general agreement that a typical lean plant provides low levels of job control and empowerment (see Appelbaum and Batt, 1994; Babson, 1993; Bruno and Jordan, 2002; Conti and Wagner, 1993; Jones et al., 2013; Lewchuk et al., 2001; Niepce and Molleman, 1998; Parker and Sprigg, 1998; Parker, 2003; Turnbull, 1988). Few studies found mixed effects (both negative and positive) on workers' autonomy (Jackson and Mullarkey, 2000). In Jackson and Mullarkey's study autonomy variables were tested in two teams; a lean and a traditional one in the same company. Timing control was lower in the lean team compared to the traditional one where breadth of role of workers was higher.

Lewchuk et al. (2001) in a comparative study between lean automobile industries in Canada and UK concluded that lean production is not associated with increased empowerment or greater employee control over work. The findings varied more between companies than across countries. The variations were accounted for by different lean implementation strategies and poor relations with the unions. The study examined specific indicators of empowerment and job control that give added value to the conclusions. It also provided evidence that the context within which lean production is applied is important (industrial relations, productivity goals etc). Hampson (1999) observed that the surrounding social factors (e.g. union power and the means they have to implement their will) determine whether 'lean becomes mean' when it is implemented in an organisation. Bruno and Jordan (2002) studied a cohort at Mitsubishi Motors where lean production was fully implemented for 8 years. Workers seemed frustrated with the rhetoric of empowerment in an environment offering no real power. Furthermore workers felt that management had used the production system against them. Quality circles were not functioning, as the work was dictated by the management and the workers felt their ideas were rejected or stolen by the management. Bruno and Jordan's study used a large cohort of workers after a significant period of lean implementation time. Nevertheless the situation described seems to have been an extreme and 'hard' lean implementation. Conti and Wagner (1993) describe quality circles 'as a system according to which employees spend 4 h a month on making their work for the rest of the month even more Taylor-like'. Appelbaum and Batt (1994) and Babson (1993) also recognise the limited opportunity quality circles have to influence managerial decisions. Fucini and Fucini (1990) reported that only suggestions by workers that are aimed at reducing costs, raising productivity or reducing time to perform tasks had a chance of being implemented by management. Parker (2003) made a before and after comparison of the introduction of lean practices in an assembly plant and also used an internal reference group of technicians who were not exposed to the lean production processes during the study period. The study concluded that lean production reduced job autonomy, employee participation and skill utilization. Parker supports the arguments of other researchers (e.g. Delbridge et al., 1992) that the multiple tasks in lean production teams actually represent multitasking instead of multiskilling. Parker also concluded that participation in decision-making in these teams was restricted. Niepce and Molleman (1998), in a theoretical approach of lean production application, explain that autonomy is difficult to achieve because the standardisation of work processes leaves little room for job control. Moreover teams are built around the supervisor and cannot be autonomous. They argue that "participation of workers in lean production exists but is limited to certain areas of decision-making (e.g. quality, work procedures) and certain mechanisms for involvement (e.g. quality circles, improvement teams)". These authors conclude that the success of workers' participation in a work system depends on how it is introduced and applied. In lean production workers are expected, for example, to submit ideas for improvement in a standardised way (e.g. a certain number of ideas per period). Salvendy (1997) concurs concluding that "Enforced participation and quality circles, where ongoing suggestions for improvement are compulsory and part of the workers' job description, have been viewed with suspicion by trade unions".

Other authors have sought to explain the failure of lean production to deliver all of its promises and for some researchers the explanation is the partial adaptation of its principles by many companies. Lean production applied in manufacturing in various countries differs, for example, from the original lean concept developed in Toyota in the automobile industry in Japan (Smith and Elger, 1998). Ichniowski and Shaw (1997) found evidence, for example, that companies in the US have not adopted all of the institutional aspects of lean production systems in Japan; the most notable absence being the promise of lifelong employment. Therefore some of the potential positive effects of lean production have not been transferred to other cultural environments. Pfeffer (1998), for example, considers employment security a critical element of high-performance work systems such as lean production.

Jones et al. (2013) investigated how managers of lean production plants maintain the illusion of employee empowerment. In the report a case study from a lean plant is used to illustrate the methods applied. The case study dealt with the investigation of sexual harassment incidents. During this investigation worker involvement was suppressed and the problem was handed over to external consultants. Worker involvement was only asked for to establish a set of company values and consensus was reached when the values reflected the views of the managers. Thus, the authors suggests, an illusion of worker empowerment was created. Finally the solutions suggested (a corporate hotline direct to the president's office and establishing mini-Human Resources teams in manufacturing areas) increased management surveillance rather than empowering workers. The authors conclude that this process is common in lean production systems: i.e. there is a consensus decision-making process but it is manipulated by the management to favour cost and production solutions. This study is unusual in constructing a theoretical basis to explain why there is a belief that lean production can include employee empowerment but the reality is different. However, it is difficult to generalise from the findings of only one case study.

From these studies it seems there is a rhetoric that lean production can lead to many benefits for workers, including empowerment and job control, but that the reality can be very different. Fig. 2 summarises the discrepancies between lean production theory and practice that have been identified by these researchers.

In conclusion, as a result of a review of the promised benefits of lean production, it does not appear by definition to create challenging and fulfilling work. Researchers are questioning whether real empowerment and autonomy can be gained for workers. The standardisation of work processes in lean production methods can hinder empowerment and job control. However, lean implementation is not the same across different companies, sectors and continents and the outcomes can depend upon what is implemented and how.

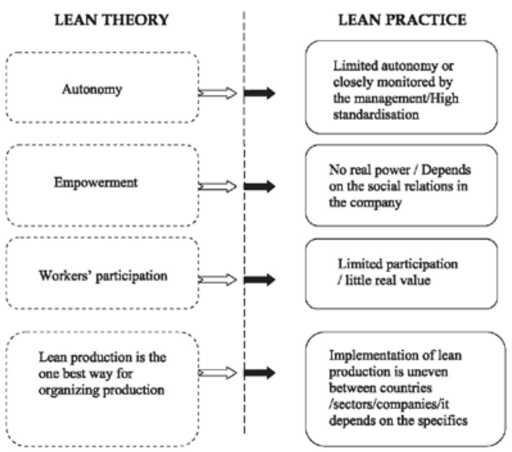

Fig. 2. Benefits of lean production – discrepancies between theory and practice.

5.2. Evidence on adverse health and safety effects of lean production

Today there are some data available – from US and Europe – to answer questions about the impact of lean production on job dimensions and health. The 36 studies reviewed below that have studied the adverse health and safety effects of lean production systems are mostly from North America and are in the automotive manufacturing industry. However, a number of small-scale surveys investigating effects of lean systems on health and safety are included that have been conducted in Europe, and are in other manufacturing industries or in service sectors.

The studies reviewed investigated associations between lean practices and risk factors like job demands, work pace, ergonomic risk factors; positive outcomes such as decision authority, skill development, autonomy and job satisfaction that if absent or low can be a risk factor, and effects like upper extremities musculoskeletal disorders, fatigue, strain and stress. The majority of lean studies reviewed investigated psychosocial factors and related effects. Some studies examine both psychosocial and ergonomic risk factors and health effects. Finally a few studies look specifically at musculoskeletal disorders (MSDs).

In Table 2 an overview of the results of the studies is given. In total more than half of the lean studies report negative outcomes for risk factors and health effects. One third of the studies have mixed outcomes. In the automotive industry 90% of the studies report negative outcomes whereas in manufacturing mixed effects outnumber the negative ones. Finally in services there is a relatively equal distribution of all types of outcomes.

Table 3 presents an overview of the 36 studies reviewed and their main findings organised according to sectors (Appendix). The classification of sectors distinguishes between manufacturing other than automotive (10), automotive industry (16) and services and mixed sectors (10). Studies received marks in the last column, according to the type of outcome they found on risk factors and health effects. Positive outcomes were marked as (+), mixed outcomes, i.e. both positive and negative, as (+/−), negative outcomes as (−) and neutral as (0).

An analysis of trends in lean production and its effects is presented in Fig. 3. The analysis identifies three time periods in which studies were undertaken when there were different approaches to lean implementation and different findings about the effects of these implementations. The first period is after the implementation wave of lean production in automotive industries in US and Canada (1991–1997). Inevitably the research at this time was carried out in the automotive industry and the focus was on musculoskeletal disorders and stress. The majority of studies report negative effects related to faster work pace, increased upper limb disorders and perceived stress. The second period is shorter (1998–2000) and covers studies carried out mostly in Europe that investigated other manufacturing sectors than the automotive industry. In this period lean production migrated from the automotive industry into other manufacturing sectors and expands from the USA to Europe. The research focus started to shift from mechanical exposure and health effects such as musculoskeletal disorders to psychosocial factors and stress. The findings from these studies are mixed with some job characteristics negatively affected and others positively. The reason behind the shift from negative effects to mixed outcomes might be that the work characteristics that cause musculoskeletal disorders were not so extreme (work pace, long working hours, etc.) in these manufacturing sectors compared with the automotive industry. Another reason might be that in these manufacturing companies hybrid forms of lean production were implemented rather than the full forms introduced in the automotive industry and that some of the characteristics of lean production that lead to adverse effects were not implemented. In the last period from 2000 to the present the studies were undertaken in a range of sectors that included service organisations that had gradually started to implement lean practices. The results include controversial both negative and mixed effects. The nature of the effects depends on two factors: first, the sector (e.g. the automotive industry nearly always shows negative effects) and the way lean practices are implemented (e.g. management decisions on which lean practices to implement and how).

Table 2
Overview of studies results on lean effects.

Sectors	(+)	(+/-)	(−)	(0)	Total
Manufacturing	–	6	3	1	10
Automotive industry	–	2	14	–	16
Services – mixed sectors	3	2	3	2	10
Total	3	10	20	3	36

As a result of these studies theoretical perspectives on the effects of lean production have evolved through the years. When lean production was first introduced it was presented as an efficient system for production that also had positive effects for workers, increasing their autonomy and empowerment. The first cluster of studies on the effects of lean production led to the conclusion that lean practices were inherently harmful to the workforce. However, the more recent studies in other manufacturing sectors and in the service sector where the degree of lean implementation level was lower demonstrated mixed effects. Consequently new theoretical ideas have begun to emerge that propose that the effects found are strongly associated with specific characteristics of lean production and their implementation. In particular practices such as Just-in-Time were identified as responsible for most of the adverse effects on health and safety of workers.

A more detailed presentation of the main studies reviewed on lean production/Just In Time organisations will follow using a classification of the different effects on health and safety: musculoskeletal disorders (MSDs) in Section 5.2.1 and job stress in Section 5.2.2 respectively.

5.2.1. Lean production and the development of musculoskeletal disorders (MSDs)

Landsbergis et al., in 1996 and 1999 reviewed several studies that examined records of musculoskeletal disorders in lean production workplaces. The majority of the studies found a moderate association between lean production and Upper Extremities Musculoskeletal Disorders. In industrial settings other than automotive manufacturing the evidence of adverse outcomes was more equivocal. Several case studies, mainly from the automotive industry investigated the specific relationship between increased work intensification and rationalisation of production in lean companies and MSDs. In their case study of CAMI (A Canadian joint venture between GM and Suzuki) Robertson et al. (1993) made a case for such a link. They argued that increased hours led to the number of reported MSDs more than doubling during the years 1992–1994. MSDs rose from 12% to 33% of all reported injuries.

In the NUMMI (New United Motor Manufacturing, Inc.) case study (Adler et al., 1997), it was reported that during lean implementation, absences due to health and safety problems increased by 12%. Treece (1989) found that workers at the NUMMI plant worked 55 s out of every minute.

In a more recent study (Brenner et al., 2004) matched data on workplace transformation (e.g., quality circles, work teams, TQM, job rotation and just-in-time production) at a number of establishments with measures of MSDs at these same establishments to

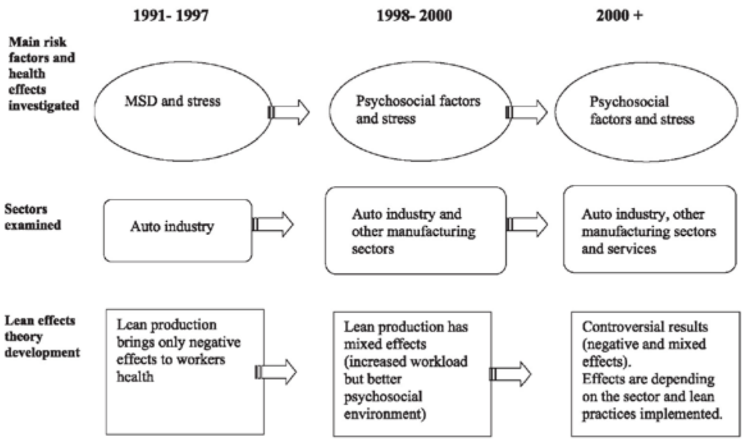

Fig. 3. Trend analysis on lean effects literature.

explore the relationship between "flexible" workplace practices and workplace health and safety. This study established a positive, statistically significant, and quantitatively sizable relationship between MSDs and the use of quality circles and just-in-time production. These two work practices collectively accounted for 50% of the mean MSD rate in these companies. The proposed explanation of the positive relationship between MSDs and these lean practices was that Just-In-Time inventory and quality circles led to reduced cycle times, speed ups and ill-fitting parts that increased worker responsibility and reduced worker empowerment. The results further suggested that these two practices had more pronounced effects when they are applied together rather than exist separately in establishments. This study is noteworthy because of its large sample (no of establishments = 1.848) and the strength of the findings. However, whilst attention is paid to the mechanisms by which Just-in-Time can have negative results no explanation of how quality circles lead to negative effects is provided.

A problem in monitoring work-related health effects such as MSD complaints in lean environments is under-reporting. In lean production work is organised in teams. In teams the cost of an absence is high, because the absence of an individual not only means the loss of this person' production, but affects the productivity of others. Workers in lean teams tend to refrain from reporting injuries or asking for sick leave. Adler et al. (1997) suggested that in automotive industries there was a climate that encouraged working in pain. Berggren et al. (1991) in their study of automotive plants in North America also reported peer pressure to 'work in pain' and not report injuries.

Christmansson et al. (1999) reported that lean redesign introduced more tasks for assembly workers (including material handling, set up of equipment and administrative work). Increased task variation combined with lack of skill and competence, increased physical stress and risk of disorders. However, there was no change in the prevalence of MSD symptoms. This study makes an interesting comparison of an assembly line before and after redesign implementing lean practices. A limitation of the study is the fairly small sample.

Womack et al. (2009) in a recent study compared a lean automotive plant with a traditional one. They examined the relationship of lean job design with musculoskeletal risks. Repetition was found to be higher at the lean plant ($p = 0.001$). The mean rating for repetition was 5.5 compared to 5.0 at the traditional plant based on the hand activity level (HAL) scale (Latko, 1997). However, peak hand force was lower at the lean plant and awkward postures were not statistically different for the two plants ($p = 0.05$). The overall conclusion was that there was no difference between the total risk index for the lean plant and that of the traditional plant.

Lloyd and James (2008) in a study in the food processing industry described a customer-controlled just-in-time system that was integrated in the supply chain. High prevalence of upper limb disorders was reported due to repetitive jobs and increase in work pace. A recent study investigated impact on mechanical exposure for dentists due to rationalisation in public dental care in Sweden (Jonker et al., 2013). Particularly flexion/extension of the head, trunk and upper arm elevation were recorded during value added work and non-value work (waste) activities. The recordings were made in 2003 and 2009 after the implementation of rationalisation. No major differences were found between baseline and follow up. However, although as a result of rationalisation initiatives waste activities were expected to be reduced, in this study they showed an increase. Accordingly, no major changes in mechanical exposure at job level could be shown.

In conclusion lean production especially in the automotive industry is associated with increased MSD symptoms of workers particularly in earlier studies. The reported results may reflect 'rigid' lean implementation strategies applied in the automotive industry in the 1990s and may be the result of increases of work pace and lack of recovery time in lean companies caused by Just-in-Time systems. Moreover, pressure from team working may have prevented workers from reporting their symptoms and forced them to work in pain. Studies in other manufacturing sectors implementing lean production have provided some evidence for an increase in musculoskeletal risk factors but not for an increase of MSD prevalence. Longitudinal studies are required to study the long-term effects of lean manufacturing.

5.2.2. Lean production and effects on job stress

There is an extensive research literature on the relation between job stress and lean production and the results are often contradictory. Several studies are ethnographic analyses of Japanese automotive plants in the US (Conti et al., 2006). These papers depict fast paced, high intensity, high stress environments. Berggren (1993) characterises lean production in automotive industry as 'mean production'. According to Berggren the experience of Japanese lean production transplants to the US has been problematic. Specifically the 'mean' characteristics of lean production were relentless performance demands, unlimited working hours and a rigorous factory regime. Also Niepce and Molleman (1998) have criticised the type of lean production developed in the Japanese car industry. They have pointed out that some key features of lean production, such as continuous flow of production and lack of buffers result in time pressure and stress.

Researchers have raised the question of whether lean production is deterministically stressful and that the benefits gained are at the expense of workers (Bruno and Jordan, 2002; Brenner et al., 2004; Lewchuk et al., 2001). Some other studies at about the same period were more favourable to lean production. In a longitudinal study in the UK (Mullarkey et al., 1995) it was concluded that it is possible to introduce Just-in-Time and team working without detrimental effects on operator's psychological well being. In a comparison of lean and traditional lines at a UK board plant (Jackson and Martin, 1996) Just-In-Time was found to be implemented without adverse impact in terms of employee strain. However, the study showed a reduction in timing control when Just in Time was implemented that could lead to psychological strain. This is a comparative pre-post study that is beneficial for examining lean effects.

Quite recently new studies 'sympathetic' to lean production have started to re-emerge. These studies question whether lean production is inherently stressful and look for correlations between stress and specific lean characteristics and practices (Conti et al., 2006; Taylor and Taylor, 2008). In the Conti et al. study (2006), one of the few large scale, multi-industry studies of lean production companies, the relationship between stress levels and lean production implementation was investigated. Total job stress was the sum of the physical and mental stress levels, which was measured by the ASSET survey instrument (Faragher et al., 2004). The results indicate that lean production is not inherently stressful and that there is no deterministic link to worker well being. Stress outcomes depend heavily on management choices in designing and operating lean systems. The study was based on the Karasek job stress model (Karasek and Theorell, 1990). This model incorporates the effects of job demands, job control and job support. In total 20 lean practices that correspond to job demand, job support and job control were tested for correlation with stress. Eleven practices were significantly related to stress (statistical significance $p = 0.05$ or less). In particular the significant job demands with positive correlation to stress were: work pace/intensity ($p < 0.001$), resource removal ($p < 0.009$), working longer than desired hours ($p < 0.001$), cycle time ($p < 0.002$), doing work of absent workers ($p < 0.002$), feeling blame for defects ($p < 0.001$) and ergonomic difficulties (the degree of difficulty in accessing, handling and positioning components in completing tasks) ($p < 0.001$). Working overtime had the strongest relationship with stress. Long hours created both higher physical job demands and lower control over personal time. The ergonomic difficulties experienced in performing tasks had the second strongest positive correlation with stress. The relationship of work pace/intensity to stress was the third largest correlation. The intensity levels reported by workers, in the ASSET questionnaire, were quite realistic compared to the ones observed on plant tours. Also the relationship between stress and the degree to which worker's felt to blame for defects is noteworthy considering the low frequency of defects in lean production. It appears that the blame feeling persists long after actual defect episodes. Finally, workers experience increased pace and intensity when performing both their tasks and those of absent workers.

The job support dimensions team working ($p < 0.001$) and task support ($p < 0.005$) had significant negative relationships to stress (as job support was increasing, job stress was decreasing) and lack of adequate tools had positive correlation to stress ($p < 0.010$) (as lack of adequate tools was increasing, job stress was also increasing). Team working also had a negative relationship to stress. It appears that the positive support of teams outweighs their shortcomings. Also task support from co-workers and supervisors reduces job demands and subsequently stress. The job control dimension, worker participation in process improvement, had a significant negative relationship with stress ($p < 0.009$). Total implementation lean level was also tested for positive relation with job stress. Un unexpected non-linear response of stress to lean implementation was identified. At an initial stage stress is increasing until a certain point. Further implementation is associated with decreasing stress. This hypothesis was rejected since the relationship between lean implementation and job stress is more complex than hypothesised.

The main value of this study lies in the fact that it systematically tested all lean practices and their correlation to stress. It sheds light on particular conditions where lean production can be stressful to workers. Moreover it directly assessed job stress with the ASSET questionnaire in contrast to other studies that usually only assess psychosocial factors. However, the authors conclude that the stressful practices do not appear to be a necessary condition for achieving the benefits of lean production. It is debatable whether this is valid. Some of the lean practices that were positively correlated to stress are fundamental to lean implementation such as work intensity caused by reduced cycle time. Other authors have blamed these practices for increasing stress in lean systems.

Schouteten and Benders (2004) also used the Kararek's Job Demand – Job Control model to evaluate quality of working life in a lean bicycle manufacturing plant in the Netherlands. Positive and negative results were also found in this lean environment. Job content was hardly challenging (short cyclical and routine tasks) but there was enough control capacity to deal with problems. Still job control in general was found to be low. Regarding the health outcomes workers reported a great need for recovery. This can be explained by the fact that the work in the factory was physically exhausting due to the repetitive short cyclical work. The takt time was very short at 1 min. Also workers reported rather low job satisfaction and commitment. However, very few workers reported an intention to resign. The sample of the study was relatively small.

In conclusion some characteristics of lean production seem to correlate with stress of workers, namely reduced cycle time, reduction of resources, mistake proofing, standardised tasks particularly if job control is low and some aspects of team working if no support is provided among co-workers and supervisors. The strongest correlations with stress were found for Just-in-Time characteristics of lean production related to reduced cycle time and reduction of resources.

6. A pathway from lean production to stress, health effects and positive outcomes

In this section an interaction model is proposed illustrating the relations between lean practices and risk factors. Fig. 4 demonstrates a pathway between the lean characteristics to musculoskeletal and psychosocial risk factors but also to positive outcomes. Two models with the basic risk factors leading to psychosocial (Karasek and Theorell, 1990; Siegrist, 1996) and musculoskeletal health effects (Bongers et al., 1993; Bernard, 1997; Devereux et al., 1999; Punnett and Wegman, 2004; Silverstein et al., 1996) are presented at the left and right columns of the table. In the central column; the basic lean production characteristics are linked to

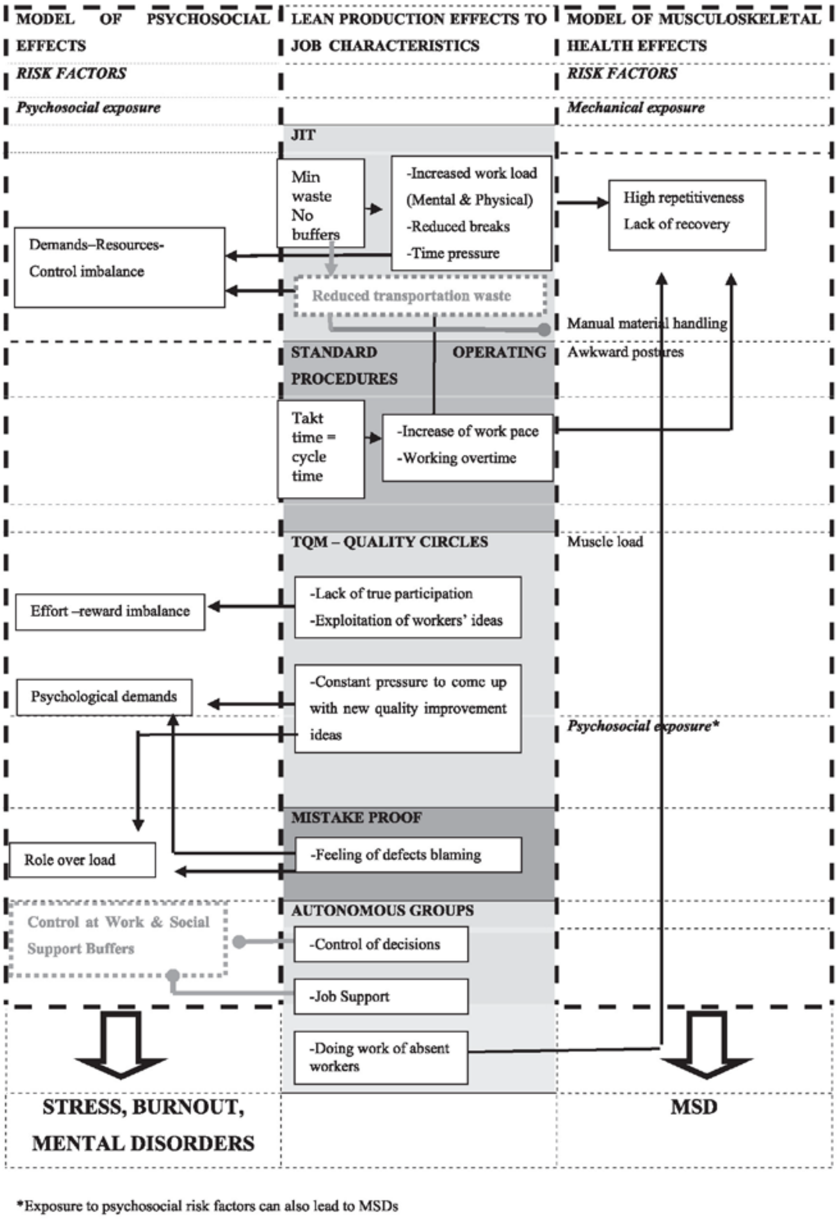

Fig. 4. Interaction model of lean production characteristics to risk factors.

subsequent effects to job characteristics. These new job characteristics result in exposure to specific risk factors in the psychosocial and musculoskeletal models. This model was inspired by the general models of Westgaard and Winkel (2011) (Figs. 1 and 2, p. 266 and 267 respectively). The associations depicted are based on the findings of this literature review.

Lean characteristics such as waste reduction, Just-In-Time and standardised work, all aimed at maximising efficiency within the cycle time, cause intensification of work that is linked with both basic psychosocial and mechanical exposure to workers. Nonetheless some types of waste reduction namely motion and transportation waste can have a positive effect that reduce several mechanical risk factors for MSDs such as awkward postures and manual handling. However, manual handling in lean plants was found to be increased in two of the studies.

Other lean characteristics such as Total Quality Management and 'Mistake proofing' seem to expose workers to different psychosocial risk factors such as effort-reward imbalance and role overload. On the other hand, lean characteristics can also be connected to positive job characteristics such as 'control of decisions' and 'job support' that act as buffers to the psychosocial effects and stress (marked grey in the model). That is, if genuine control of decisions at work and social support from team colleagues and supervisors is possible within the autonomous groups of lean production. The clarification in control at work (control of decisions) is made here since only some aspects of control can be achieved. Control of work pacing is not possible in lean systems.

What is apparent from this model is that lean production has a greater impact on work-related stress compared to musculoskeletal disorders. That is because lean characteristics influence concurrently a number of psychosocial risk factors that have a direct effect on workers.

7. Discussion

The current paper made a literature review across the last 20 years (1990–2013) and has included several studies on lean production effects in automotive manufacturing and other sectors (Conti et al., 2006; Leroyer et al., 2006; Lloyd and James, 2008; Mehri, 2005; Parker, 2003; Saurin and Ferreira, 2009; Schouteten and Benders, 2004; Seppala and Klemola, 2004; Sprigg and Jackson, 2006; Womack et al., 2009; etc.).

Overall the findings of the surveys and literature reviewed indicate that the effects of lean production on working conditions are more evident in the automotive industry (increased stress and symptoms of MSDs) and less evident in other manufacturing sectors. In manufacturing an increase in workload was observed for half of the studies but not always linked to increased strain. Other studies demonstrated either no change (Mullarkey et al., 1995) or both negative and positive effects of lean production on workers (Conti et al., 2006; Jackson and Mullarkey, 2000; Saurin and Ferreira, 2009; Schouteten and Benders, 2004, etc).

In services and other sectors the outcomes seem to be more balanced. It is in this section that all the positive outcomes have been reported. These positive outcome studies describe self-managed teams and empowerment of workers.

Parker (2003) has attributed these inconsistencies in the findings to the problem of what constitutes lean production and how it is implemented because this varies considerably among studies. Lean production was originated in Toyota in Japan and then transferred to US automotive plants. So it is logical that in the automotive industry the lean implementation is full and its effect on working conditions may be expected to be more evident. Moreover some organisations introduce hybrid forms that include aspects of lean and other production systems. Such forms are more prevalent in manufacturing and other sectors.

Parker (2003) concluded that lean production is likely to have different consequences for work characteristics depending on the different elements of lean production that are introduced. In particular in her study the installation of a moving assembly line was associated with severe negative effects on work characteristics and employee outcomes (increased job depression) compared to lean teams and workflow formalisation and standardisation (inventory reduction and processes simplification and standardisation) that had negative but not so extreme effects. Conti et al. (2006) identified eleven particular work practices significantly related to job stress. Those were work pace/intensity, resource removal, working longer than desired hours, cycle time, doing work of absent workers, feeling blame of defects and ergonomics difficulty.

The characteristics of lean production that seem to have overall the strongest association with negative effects on workers in this study are Just-I-Time practices such as removal of waste and non-value activities. It appears that these practices are causing intensification of work that is linked to increased levels of strain and stress. Parker and Conti are part of a new school of thought in lean production research, advocating that lean production is not by definition harmful. Specific lean characteristics can have adverse effects on work characteristics and workers' health. Moreover what are of great importance are the choices companies make in lean implementation. For instance a company could choose to apply one lean characteristic to its extreme, (e.g. removal of 'waste activities'), that has a direct effect on work intensification, while minimising other characteristics that could act as a buffer to stress (e.g. autonomy and group support in teams). This dangerous combination could only bring about the unfavourable effects of lean production.

In their review Westgaard and Winkel (2011) investigated potential 'conditions of work' mentioned as modifiers (described here as buffers) that could alleviate lean effects. The most important ones were group autonomy, social support at work and worker participation when a lean system is introduced and in improvement programs.

The analysis of studies made in different periods of time showed the changing trends in both the application of lean practices and the effects on workers over a 20 year period. Theories of the effects of lean production effects have evolved from a view that it is an inherently harmful management system to a system that can have mixed effects depending on management style and the way it is implemented. However, there are specific lean practices that lead to negative effects that are fundamental to lean production and cannot be omitted if lean methods are claimed to be adopted. The underlying mechanism of lean production, as illustrated in Fig. 4; is intensification of work. Just-in-Time practices are causing intensification of work and they are the practices that trigger health effects.

In conclusion, recent research on lean production reported that negative effects on workers are strongly associated with some lean practices. Specific lean practices such as Just-in-Time and standardised work cause intensification of work and are strongly associated with both mechanical and psychosocial exposure. However, this cannot lead to the conclusion that lean production is not by definition harmful. Waste reduction practices are considered to be the core of lean production and without them a production system can hardly identify itself as lean. Not all lean characteristics are harmful but the core ones can be harmful if no buffers (such as job control and social support) are applied. In conclusion it is not only the level of lean implementation that correlates to risk factors but also the type of lean characteristics that are applied. The main underlying mechanism for the health effects of lean production is the intensification of work and that in some cases is unavoidable.

Finally we can examine how the evolving story of lean production relates to concepts in sociotechnical systems theory (STS). A central concept in STS is the interdependencies that exist between the technical and social sub-systems that, in some instances can produce very tight couplings (Thompson, 1967; Perrow, 1999) in which, for example, the characteristics of the technical system have direct effects on the social system. Eason and Waterson (2013) have, for example, shown how tight coupling caused by everybody using the same electronic patient record can have adverse effects on the autonomy of different groups of healthcare workers. In the present context some of the core components of lean production such as JIT have such direct effects and have adverse implications for the health of the workforce. There are two other features of this analysis that relate to enduring themes in STS. The first is that there are ways in which the social system can mitigate adverse effects of the technical system. The book that described one of the original STS studies in British coal mines was called 'Organisational Choice' (Trist et al., 1962) because the effects of a new mechanised technical system were different in two coal mining areas because of local organisational arrangements. In the case of lean production the use of buffering mechanisms has been shown to mitigate the adverse effects. However, what the lean production case also shows is that there is also technical choice: it is not one integrated technical system but an array of components that can be implemented fully or partially. Assessing the risk associated with a broad approach such as lean production depends therefore on an understanding of the systemic interdependencies created by each of the components.

Niepce and Molleman (1998) and Paez et al. (2004) raised the question of whether lean production and sociotechnical systems design are compatible. It is increasingly apparent that in both cases there is flexibility in the choice of the technical and social components that makeup the overall system in each case. By selecting appropriate components it may be theoretical possible to construct an overall system that meets the objectives of lean production and of sociotechnical design. However, this review strongly suggests that there are core practices in lean production that have direct and adverse affects on workers and it remains difficult to see how these practices can be reconciled with core sociotechnical systems design principles that emphasise local autonomy and discretion in relation to task performance.

Appendix

Table 3
Overview of Lean Production studies investigating risk factors and health outcomes.

Authors/editors	Study design	Sector	Outcome measure	Results
Manufacturing other than automotive				
Bao et al., 1997	Cross sectional study	Manufacturing (Cassette recorders assembly vs assembly of sewing machines (lean practices))	Mechanical exposure measures, Rest pauses	Higher frequency of upper arm movements, faster work pace, reduced rest pauses (−)
Christmansson et al., 1999	Pre-post	Manufacturing (door and windows handles production) before and after lean	Ergonomic factors, upper limb MSD prevalence, autonomy, control, variety and job satisfaction	No changes in MSD prevalence (0) Increase in manual handling and frequency of movements, mixed effects on psychosocial factors (+/−)
Conti et al., 2006	Cross sectional study	Metal industry and electronics	Job stress	Lean production was not found inherently stressful and stress levels were significantly related to management decisions in designing and operating lean production systems. In particular eleven work practices were found to be significantly related to job stress (+/−)
Jackson and Martin, 1996	Pre-post study	Electronics	Demands, production pressure, control, job satisfaction, psychological strain	Reduction in control over work timing, increase in production pressure, drop in job satisfaction. No change in control over work methods, cognitive demands and psychological strain (−)
Jackson and Mullarkey, 2000	Cross sectional study	Garment manufacture	Demands, autonomy, social climate	Both positive and negative effects on autonomy, work demands and social climate (+/−)
Lloyd and James, 2008	Historic perspective	Food processing	Upper limb disorders prevalence, work pressure	High prevalence of upper limb disorders, increased work pressure (−)
Mullarkey et al., 1995	Time series	Electronics	Demands, control, coworker support, job satisfaction, psychological strain	Introduction of JIT was associated with no change in existing levels of employee autonomy, job demands and employees strain (0)
Saurin and Ferreira, 2009	Historic perspective	Assembly workers	Work pace, workload, general working conditions	Work pace and workload were increased, general conditions improved (+/−)

Table 3 (*continued*)

Authors/editors	Study design	Sector	Outcome measure	Results
Schouteten and Benders, 2004	Case study	Bicycle manufacturing	Demands, control, job satisfaction, commitment	Job control was found low. In general job demands were found low. However takt time was very short and the need for recovery was reported high. Workers reported rather low job satisfaction and commitment (+/−)
Seppala and Klemola, 2004	Historic prospective	Metal industry	Time pressure, psychological strain and stress	Blue collar and white collar employees often had experienced time pressure at work. The white collars employees and some blue collar (maintenance and material workers) experienced their work as mentally strenuous and stressful (+/−)
Automotive manufacturing				
Adler et al., 1997	Longitudinal	Auto industry	MSDs, stress	Absences due to health and safety problems increased by 12%. Within the first month of production upper limb disorders more than doubled and back and neck cases increased 7 times (−)
Babson, 1993	Historic prospective	Auto industry	Workload	Workload increased after introduction of lean practices (−)
Berggren et al., 1991	Case study	Auto industry	Stress, MSDs	Reported high levels of perceived stress and of musculoskeletal disorders, due, in their opinion, to the fast work pace, long work hours, highly repetitive work, and limited rest breaks (−)
Brenner et al., 2004	Cross sectional study	Auto industry	MSDs	JIT and quality circles are both positively and statistically significantly associated with MSDs rates across establishments (−)
Bruno and Jordan, 2002	Cohort study	Auto industry	Empowerment, skills utilization, involvement, job control	In the 1989 study 50% had a positive attitude about management and work environment. In 1997, 96% found work life negative. There was universal discontent with Quality circles, nearly 50% had negative impression of kaizen, 30% complained that work has become more 'physically rigorous' and safety was neglected (−)
Graham, 1995	Case study	Auto industry	MSDs	Increased hand and wrist injuries due to increase of line speed (−)
Leroyer et al., 2006	Time Series	Auto industry	Health of workers, job demands	Reduced heath, psychological and physical demands increased (−)
Lewchuck and Robertson, 1996	Cross sectional study	Auto-assembly companies	Workload	Workers reported increasing and faster workloads compared to Fordism plants (−)
Lewchuk and Robertson, 1997	Cross sectional study	Auto industry	Work pace, job demands	High work pace, Increase in job demands with level of lean (−)

(continued on next page)

Table 3 (*continued*)

Authors/editors	Study design	Sector	Outcome measure	Results
Lewchuck et al., 2001	Comparative study	Auto industry	Job control, workload, health & safety conditions (pain or discomfort, ergonomic stressors, exhaustion)	Lean production is not associated with increased empowerment or greater employee control over work. On the contrary employees report quite different experiences of work effort, health & safety and relations with management (−)
Mehri, 2005	Qualitative	Auto industry	Injury and illness reports, workload	High reports of injuries and illnesses, high workload (−)
Parker et al., 1995	Case study	Car seat manufacture	Work load, psychological strain	JIT increased employee work load (not in cognitive demand) and psychological strain (−)
Parker, 2003	Longitudinal study	Assembly of large vehicles	Job autonomy, skill utilization, participation in decision-making, psychological strain (job anxiety and job depression)	Employees in lean production groups had declines in job autonomy, skill utilization and participation in decision-making. Job depression was increased. (−)
Parker and Sprigg, 1998	Longitudinal study	Auto manufacturing (truck)	Job control, skill variety, demands, job satisfaction, workload, job strain	Workers reported reduced autonomy and task variety, increased stress, decreased job satisfaction and reduced organizational commitment. Employees involved in the cell certification process had positive mental health outcomes, especially where there were high levels of management support (+/−)
Robertson et al., 1993	Case study	Auto-assembly plants	Workload, MSDs, stress	Reported MSDs were doubled between 1992 and 1994 due to increased hours and overburdened jobs. Increased stress (40%) (−)
Womack et al., 2009	Cross sectional study	Auto industry	Ergonomic risk factors	More repetitive jobs, lower peak hand force ratings, same demands in postures, no difference in the overall risk index (+/−)
Services – mixed sectors				
Batt and Appelbaum, 1995	Cross sectional study	Customer service and network craft workers	Job satisfaction	Higher job satisfaction in self-managed teams when dependence from other teams was low (+)
Batt, 2004	Cross sectional study	Telecommunications	Job satisfaction	Self-managed teams reported more job satisfaction (+)
Carayon et al., 1999	Cross sectional study	Office work	Workload	TQM increased workload but improved other psychosocial factors (+/−)
Härenstam et al., 2000	Cross sectional study	Mixed sectors (services and manufacturing, private and public sector)	Workload, work control, support and development possibilities	80% working in lean production workplaces reported increased workload, 40% reported increased work control (−)
Harley, 2001	Cross sectional study	Mixed sectors	Stress, job satisfaction	No effects of teams in stress or job satisfaction (0)
Karia and Asaari, 2006	Cross sectional study	Mixed sectors	Job satisfaction	Higher job satisfaction with training and empowerment (+)
Klein, 1991	Comparative study	Auto industry, engine manufacturing and instrument manufacturing	Job autonomy	JIT and standardisation practices offer limited autonomy to workers (+/−)

Table 3 (*continued*)

Authors/editors	Study design	Sector	Outcome measure	Results
Sprigg and Jackson, 2006	Cross – sectional study	Call centers	Job autonomy, skill utilization, workload, role conflict, job clarity, task variety, job strain	Employees who practice certain lean characteristics (greater dialog scripting and more intensive performance monitoring) experience higher levels of strain. Dialog scripting is also associated with lower autonomy, lower task variety and skill utilization, lower role clarity, higher workload, and higher role conflict (–)
Vendramin et al., 2000	Empirical Case studies (Belgium, Denmark, France, Italy, UK, Spain)	Printing and publishing, civil engineering, banking and insurance and health services	Work pace	New rhythms of production can cause intensification of work (–)
Jonker et al., 2013	Prospective cohort study	Public dental care	Mechanical exposure (flexion/extension of the head, trunk and upper arm elevation), duration of value added and non- value added work activities	No major differences between baseline and the follow up (0) The value added work activities that could lead to an increase in mechanical risk factors were reduced instead of increased during rationalisation.

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New trends in work environment – New effects on safety

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ABSTRACT

Europe has been subject to tremendous changes in terms of flexibility of work and labour in response to macro trends like globalisation and the resulting fierce market competition. Such changes in the world of work can give rise to new safety risks. Although the effects of "changing work environment" are fairly documented for psychosocial and ergonomic risks, the subsequent effects on occupational safety are less investigated. This paper sets a general framework on changing work environment presenting prominent descriptions by various institutes.

New trends in work environment including new work organisational forms, new contractual relationships, new technologies and changes in the workforce are briefly presented. This paper reviews existing evidence on the effects of changing work environment on safety and occupational accidents. It further suggests an underlying mechanism explaining these effects that is based on organizational factors. Finally it discusses safety prevention challenges to policy makers. In conclusion a sustainable work system is suggested as an alternative to intensive systems.

1. Introduction

This paper focuses on prevention of occupational accidents in a changing work environment. Although the effects of changing work environment are well documented for psychosocial and ergonomic risks, the subsequent effects on occupational safety are less explored. This paper aims at shedding some light into safety aspects of new work environment.

2. A general framework for understanding changing work environment

"Changing or new work environment" is a broad term covering new trends in work environment. For the purpose of this paper an operational description for the changing work environment is required. A terminology and description of new trends was searched in the literature, European and international reports, European studies and European Commission Green papers and communications.

Kompier (2006) identifies under the general title "Changing world of work", major trends in and around work organisations. These trends are increased internationalisation and competition, new technology, changed configuration of workplace and flexibility and new organisational practices.

National Institute for Occupational Safety and Health (NIOSH, 2002) describes a range of new organisational practices that employers have implemented to compete more effectively in the global economy. These practices are organisational restructuring such as downsizing and outsourcing, flexible and quality management initiatives such as lean production and the use of temporary and contingent (contract) labour.

The communication of the European Commission "Towards common principles of flexicurity: More and better jobs through flexibility and security" (2007), recognises several trends as a result of the globalisation:

Development of new technologies, particularly in the information and communication areas; the demographic ageing of European societies, a more flexible labour market and an increase of migrant workers.

The Green paper of the European Commission (1997) recognises the new trends in organisation of work. A number of organizational changes take place aiming at improving productivity, quality and working conditions (quality circles, just-in-time systems, teamwork).

The European Foundation in its study on flexibility and working conditions (Goudswaard and de Nanteuil, 2000) identifies as a "Changing environment" the growing competition; the increasing importance of globalisation; the intensification of work processes and a decrease in the 'time-to-market' of the goods produced. Companies seek different answers to their changing environment. Some of these answers can be defined as the 'flexibilisation' of labour.

A distinction is made between the flexible use of internal personnel (internal flexibility) and the outsourcing of tasks to temporary agencies or subcontractors (external flexibility). Then there is a further distinction between quantitative flexibility, which is the

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variation in the quantity of labour through working time patterns or the hiring of temporary or short-term personnel, and qualitative flexibility, which includes functional flexibility: the hiring of specialists for specialised tasks, or subcontracting to other (specialised) companies (Goudswaard and de Nanteuil, 2000).

The European Community strategy (Commission of the European Communities, 2007) for the years 2007–2012, acknowledges a number of challenges in the field of health and safety. Such challenges are demographic change and the ageing of the working population; new employment trends, including the increase in self-employment, outsourcing and increased employment in SMEs; and new and larger flows of migrants towards Europe. Also the strategy identifies the need for confronting new and emerging risks that are rising from new technology or work organisation.

According to the European Agency for Safety and Health at Work, "Changing World of Work" issues can be summarised as new work organisational forms, new contractual relationships and use of working time, new technologies, changes in the workforce, and changes in occupational health and safety systems (European Agency for Safety and Health at Work, 2002b).

For the purpose of this paper the above mentioned description of the European Agency for Safety and Health at Work on "changing world of work" will be adopted since it is comprehensive and encompasses all the trends recognised by other institutes.

Examples of new work environment trends are given below.

Changes in work organisational forms can be a response to the global fierce competition. Downsizing and outsourcing work is one major trend in companies across Europe and the world. Management structures elaborated in the 1980s, such as lean production and Just in time are more and more embraced by companies in order to optimise their production performance.

New forms of contractual work can be telework, self-employment, subcontracting, temporary and part time employment.

New technologies include growing use of information and communication technology, nanotechnology, biofuels and other.

Changes in the workforce are demographic changes (ageing), increasing participation of women and migrant workers.

3. Evidence for effects of changing work environment on safety

Not all aspects of changing work environment have evidence on direct effects on occupational safety. One must bear in mind that some trends such as atypical work were more closely investigated comparing to others. Nevertheless the main aspects of new trends will be elaborated in this paper and an effort to present existing evidence on their effects on occupational safety will be made.

3.1. New work organisational forms and effects on safety

Downsizing has become an extremely popular strategy in today's business environment. It is used to reduce labour costs in an effort to become more price competitive, especially internationally (Nienstedt, 1989). Downsizing has been associated with changes in work characteristics, social relationships, and health behaviours. Major downsizing was associated with increased levels of physical work demands and job insecurity and decreased levels of skill discretion and participation (Kivimäki, Vahtera, 2000). Major downsizing was also associated with an increase in sickness absence (*P* for trend <0.001) in permanent employees but not in temporary employees. The extent of downsizing was also associated with cardiovascular deaths (*P* for trend <0.01) but not with deaths from other causes. Cardiovascular mortality was 2.0 (95% confidence interval 1.0–3.9) times higher after major downsizing than after no downsizing (Vahtera et al., 2004).

A Norwegian study on downsizing in the chemical industry showed a relationship between precarious employment and increased risk behaviour (Rundmo, 2001). Several studies have identified the link between downsizing/organisational restructuring and increased occupational violence, bullying or aggressive behaviour at work (Snyder, 1994; McCarthy et al., 1995; McCarthy, 1997).

Other researchers suggested the existence of a link between job insecurity after downsizing and similar approaches and employee safety. The explanation proposed is that job insecurity causes negative job attitudes. These attitudes in turn may result in a reduction in adherence to safety policies (Barling and Frone, 2004). Another explanation for the linkage between job insecurity and reduced safety outcomes is that organisations that typically have insecurity also tend not to foster organisational cultures supportive of safety due to increased pressures for production in order to survive economically (Simard and Marchand, 1997).

Lean-production practices attempt to increase productivity through continuous improvement, improved inventory systems and elimination of wasted time and motion.

There are a number of studies that have investigated associations between lean work and job characteristics like job demands, decision authority, skill development and health effects and symptoms like upper extremities musculoskeletal disorders, fatigue, stress and strain. According to a recent review of the majority of the studies available; moderate association for lean production and upper extremities musculoskeletal disorders, fatigue and stress was found (Landsbergis et al., 1996).

On the other hand safety effects of lean production and similar management schemes have not been examined extensively by researchers.

In theory lean plants place considerable emphasis on safety and the avoidance of accidents, which can interrupt production. Also the detailed breaking up of work in tasks and sub-tasks, executed according to specific instructions in such a way so as to be carried out by inexperienced workers; can hinder mistakes and therefore near misses or accidents (Koukoulaki, unpublished). Although accidents must be avoided at all costs in lean production system, slow developing conditions such as musculoskeletal disorders are evidently viewed as less of a threat (Wokutch, 1992). However acute traumas can be considered as injury.

Other studies have suggested that supervision helps to reduce work injuries. Therefore quality circles, autonomous groups and similar approaches that reduce supervision can have a negative impact on safety (Rinefort et al., 1998).

Landsbergis et al. (1999) found detrimental effects on injury rates in a variety of industries that were implementing lean production.

Stoop and Thissen (1997) argued that highly articulated transport systems with narrow windows for service or delivery, such as just-in-time systems, are not conductive to safety. Just in time is a main component of the lean system.

The reasons behind the adverse effects of lean production and similar management schemes are the unlimited performance demands, the long working hours and requirements to work overtime on short notice, and the rigorous factory regime that constitutes a new and very strict regime of subordination (Berggren, 1993).

3.2. New contractual relationships and occupational accidents

In the EU27 in 2007, 30.7% of employed women and 6.9% of employed men worked part-time. There was a slight increase since 2000, when 28.7% of employed women and 5.9% of employed men worked part-time (Eurostat[1], 2008).

[1] http://epp.eurostat.ec.europa.eu,Populationandsocialconditions/Labourmarket/Employmentandunemployment (Labour Force Survey).

In 2007, 14.5% of employees had temporary employment contracts. There was an increase of 2% from the respective percentage in 2000 that was 12.20%. Women are still overrepresented in temporary work compared to men with the same difference the last 7 years. In 2007 15.2% of the temporary workers were women and 13.8% men. In 2000 13% of the temporary workers were women and 11.6 were men (Eurostat, 2008).

Precarious or atypical work has relatively strong associations with higher accident rates.

Huuhtanen and Kandolin (1999) refer to a Scandinavian study from 1995 to 1996 that has revealed a 10–15% higher rate of accidents for temporary workers in industry than for workers in permanent jobs. Several other authors have looked at the impacts of temporary work on safety (François and Lievin, 2000; Morris, 1999). They have observed a higher risk of accidents for workers on fixed term contracts and temporary work. An apparent two to three times higher injury frequency rate for temporary employees compared to permanent workers was identified in one manufacturing setting (Morris, 1999).

According to some studies, temporary workers also have a higher risk of occupational injuries but their sickness absence is lower (Virtanen et al., 2005).

Other studies stated that in countries where the proportion of temporary employment is high the rate of work accidents tends also to be high (Hernanz and Toharia, 2004).

From data systematically recorded for 2000 and 2001 by the Spanish Ministry of Labour and Social Affairs, temporary workers showed a rate ratio of 2.94 for non-fatal occupational injuries and 2.54 for fatal occupational injuries. When these associations were adjusted by gender, age, occupation, and especially length of employment, they loose statistic significance: 1.05 for non-fatal and 1.07 for fatal (Benavides et al., 2006).

According to the Second Work Survey carried out by the National Training Agency in Italy in 2006, the incidence of work accidents is higher among temporary workers than among permanent employees and self-employed persons when seniority is lower than 5 years (ISFOL, 2007, Table 1).

Finally there is growing evidence that contingent workers are at higher risk for work-related injury, illness, and death outside Europe too.

Several studies in the United States have demonstrated higher risk for temporary workers. For example the rate of needlestick injuries among temporary nurses caring for AIDS patients in 11 US hospitals was 1.65 times higher than the rate for staff nurses working in the same units. A 2004 survey of day labourers found that 19% of them reported work-related injuries that required medical attention in the previous year, compared with less than 5% of workers in all private industries and 6% of all workers in construction.

In a study in India, accident incidence rate, accident frequency rate and accident severity rate were found to be significantly higher in temporary piece rated workers (wages depend upon amount of work done) (Saha et al., 2004). In India, workers according to their status of employment are of three types: permanent, temporary piece rated (usually employed through contractor) and temporary time rated (wages after working for fixed period of time). This study concluded that the temporary piece rated workers are more vulnerable to occupational accidents.

Few studies have investigated the underlying mechanisms of increased risk of temporary workers. Lower job experience and knowledge of workplace hazards, measured by length of employment, is a possible mechanism to explain the consistent association between temporary workers and occupational injury (Benavides et al., 2006).

In a recent revision of studies on temporary work and injuries it is suggested that the association among temporary workers may be related to their greater inexperience and lack of safety training at the workplace, although the association may be biased by confounding related to occupation (Virtanen et al., 2005).

Other studies have found that the cause of this increased risk can be attributed to many factors (Saha et al., 2004). Effective experience and thereby safety knowledge may be relatively less in the temporary piece rated workers. The relatively increased accident risk of the temporary piece rated workers may also be due to the fact that these workers are not only temporary but also piece rated. Whenever they work, their amount of wages is in direct relationship with the amount of work done by them. So, by compulsion, they work hurriedly. This increased speed of their work may have contributed to their increased accident risk. One interesting finding of the Indian study is that the values of relative risk are higher in case of time-loss accidents than in case of no time-loss accidents in relation to both incidence rate and frequency rate. This finding is difficult to be explained by the usual factors of accident occurrence. But, it can well be explained with a statement adopted from an ILO publication (ILO, 1986), which says; "Insecurity of employment is almost certainly a cause of accidents". Scientific papers supporting this statement are elaborated in Section 3.1.

Evidence from the United States indicates that employees earn significantly less than their non-contingent counterparts and those with part time jobs in particular are likely to enter into multiple jobholding to supplement their income (Hipple, 2001). Multiple jobholding can pose safety risks (due to travel time, task reorientation and added stress) over and above those associated with longer hours in the same job (Barling and Frone, 2004).

3.3. New technology and effects on safety – the example of nanotechnology

New technology and its effects on safety is a vast topic and needs to be dealt separately. On the scope of this paper only the example of the nanotechnology will be given. Nanotechnology is a promising new technology with applications in many sciences. Nanomaterials are a wide variety of materials with a diameter of less than 100 nm.

The field of nanotechnology is relatively new, and therefore little is known about the potential occupational safety hazards that may be associated with engineered nanomaterials. However, the information that is available about the properties of nanoscale particles indicates that under given conditions, engineered

Table 1
Work accidents, by employment status and seniority (% of workers affected).

Seniority	Permanent employees	Selfemployed persons	Temporary workers
More than 20 years	21.9	23.1	17.8
11 to 20 years	21.6	4.6	19.3
6 to 10 years	12.2	3.6	9.0
Up to 5 years	3.8	–	4.7

Source: Institute for the Development of Workers' Vocational Training (ISFOL, 2007).

nanomaterials may pose a dust explosion hazard and be spontaneously flammable when exposed to air because of their large surface area and overall small size (NIOSH, 2007).

Further research is needed to determine the physical and chemical characteristics of nanoscale powders that may pose the greatest risk for fire and explosion in the workplace.

3.4. Changes in the workforce and effects on safety

As the number of young people entering employment falls in the coming years, there will be a significant increase in the proportion of older people in the workforce.

In 2001, the Stockholm European Council undertook to raise the average employment rate in the EU for men and women within the 55–64 age-group to 50% by 2010.

Ageing workforce and its employability is therefore a major concern for the European decision makers. Few studies exist though investigating demographic changes and effects on safety.

The initial results of the European Working Conditions Survey 2005, while do not provide details in relation to reasons of absences, indicate that the middle – 40–54 – age group has the highest occurrence of absenteeism – 24.6% – and the largest average number of days per absence. According to recent accident statistics the middle age group – 45–54 – share to the total accidents is 20% where for the age group – 45–64 – the share is 28% (Eurostat, 2005).

It is suggested by other studies, that only be in some tasks that a negative effect of aging on accident occurrence is to be expected (Laflamme and Menckel, 1995). These are tasks where basic capacities are increasingly exceeded by job demands as workers age, and where experience cannot compensate for this.

Finally it is estimated (Krieger, 2005) that the nine largest former EU15 Member States have between 4.4 and 5.5 million illegal migrants. Transposing these figures to the EU25 would give an estimate of between 6 and 8 million undocumented migrants.

There are several studies in different European countries, and outside Europe, on occupational accidents among migrant workers. The findings are somewhat contradictory. Bearing in mind the limited availability of reliable statistics on occupational health and safety for migrant workers in a majority of countries, existing data suggest a higher accident rate for migrant workers (European Agency for Safety and Health at Work, European Risk Observatory, Literature study on migrant workers, 2002c).

Elias et al. (2001) have undertaken an analysis of workplace injuries based upon individual level data from the Labour Force Survey. This study reveals that although variations are observed across a variety of personal and workplace characteristics, the dominant influence that effects the risk of suffering a workplace injury is occupation (HSE, 2004).

Two French studies indicated that immigrants are at increased risk of injury and ill-health due to concentration in hazardous occupations (Bourdillon et al. 1991; Bollini and Siem 1995) (HSE, 2004). So a possible explanation for the higher accident rate for migrants is that they concentrate in high risk sectors. Another hypothesis is that migrant workers take excessive risks to show their "zeal" to work in fear of loosing their job.

Research on forestry industry workers in New Zealand has identified that accidents and injuries are associated with ethnicity and long working hours (Lilley et al. 2002).

Older studies have identified the lack of language and poor communication and on-the job training as possible factors for higher workplace injury rates for ethnic minorities. A New Zealand study reports a high incidence of heavy machinery, industrial hand mutilation for recent Pacific Island immigrants many of whom had poor comprehension of English, with inadequate instruction identified as a causative factor (Bossley, 1975; HSE, 2004).

4. Identifying potential mechanisms to explain the effects of changing work environment to occupational safety

It is evident that changing work environment does have adverse effects on safety. However the situation is complex. It seems that different aspects influence safety in different ways. No doubt that if more than one aspect of "new work environment" are present, for instance temporary and migrant work, the effect would be stronger.

Probst and Brumaker (2001) have developed a model linking job insecurity, safety motivation, knowledge and compliance and job-related injuries and accidents. According to this model job insecurity results in job dissatisfaction. The latter is predicted to be related to low levels of safety knowledge and safety motivation (motivation to perform a job in a safe manner). It is expected that lowered safety knowledge and reduced safety motivation to comply with safety policies would result in a higher incidence of workplace injuries and accidents due to increased noncompliance with organisational safety policies. Job insecurity can be present in many situations in the new work environment for instance temporary work, migrant's work and companies with organisational restructuring. Therefore in this model the effect between a changing work environment and safety is triggered by a psychological factor. However it is not possible to conclude that one universal underlying mechanism can explain the effects of all aspects of a new work environment to occupational safety.

Another potential mechanism could be based on organisational factors.

Temporary and part-time workers, migrant workers but also workers in lean or restructured companies have one common characteristic, intensification of work with less recourses that is training, information, time and people. Temporary employment relationships are governed by a fixed-duration contract where the work is fairly intensive for the given time. Part-time workers are usually employed in more than one part time job resulting in excessive hours within their working week. At the same time temporary and part time workers are excluded from formal training. A study by Aronsson (1999), based on a stratified sample of the Swedish Labour Market Survey found that temporary workers were more likely than permanent workers to report deficiencies in training and occupational health and safety knowledge.

Migrant workers are forced to work longer hours and more intensively to overcome initial discrimination they might face; vis-à-vis nationals in their attempts to enter the labour market. Due to language difficulties; training and information are in most cases not possible. Lean companies or companies after restructuring (downsizing) are intensive by definition. Both systems do more with less recourses. Intensification of work in combination with lack of recourses can by-pass safety procedures. The latter could lead to increase of occupational accidents.

It has been suggested in the past that the more an organisation places an emphasis on production, the more employees perceive that safety is subordinated to the demands of production (Janssens et al., 1995). In more intensive situations and systems like those described above; this phenomenon could grow worse. In other cases organisational failings in these systems may make safety violations an essential part of getting the work done (Reason et al., 1998).

5. Challenges for prevention

New trends in work environment can lead to new effects on safety. As mentioned above, work organisations are changing at high speed. This dynamic situation requires a dynamic approach in occupational safety prevention (Grossmann and Martin, 1999).

In order to design effective safety prevention strategies in a changing work environment; its underlying mechanisms should be fully understood. Changing work environment' consequences to occupational safety are still to be investigated.

The Community Strategy (Commission of the European Communities, 2007) emphasises the importance of research into new and emerging risks for designing preventive solutions and points out that "scientific research provides arguments and evidence upon which policy decisions must be based". However the research reality in the member states is different.

According to an overview of national research management good practice in OSH related research programmes in Europe (NEW OSH ERA, 2007), a mere 0.07% of national funds is attributed to new risks research, that is remarkably low. Therefore more focused research is needed.

Another concern in the changing work environment is the validity of accidents indicator. Decreasing rates of accidents might be explained by better prevention strategies or by the exportation of dangerous activities (Thébaud-Mony, 2001). Also for temporary or illegal workers accident records are seldom kept. A more prevention oriented index might be needed.

It is a common view that the changing work environment will lead to new demands on the effectiveness of national occupational systems (European Agency for Safety and Health at Work, Research on changing world of work, 2002a).

A review on successful accident prevention strategies and the changing world of work reveals different aspects of safety management across the EU (European Agency for Safety and Health at Work, New trends in accident prevention due to the changing world of work, 2002b).

One main aspect of successful safety management is regulation. Currently there is a debate going on concerning regulation versus deregulation and promoting voluntary instruments. Many argue that European Union legislation is bulky and bureaucratic to apply especially for SMEs. Deregulation replaces the responsibility on the company management to develop their own performance indicators and to improve their management systems (Jensen, 2001).

However we are far from the point where EU regulation is complete; played its role and can be replaced. Europe is still in its enlargement stage where for some countries EU legislation is introduced for the first time. Furthermore although EU legislation on part-time work does exist, many other aspects of a changing environment are not yet covered. Over the last years, European Commission is in the process of examining the adequacy of existing legislation on certain "new risks" such as MSD risks. However there is a paradox in the European Union policies. The European Commission on the one hand carries out studies aiming at investigating new policies to tackle specific risks. On the other hand the European Council promotes extension of working hours that exposes workers at the very same risks.

In conclusion regulation will always remain the basic momentum for accidents prevention. Moreover legislation is currently facing challenges by the new trends in working life. Regulation cannot be replaced by voluntary instruments such as Corporate Social Responsibility (CSR). However CSR do not need to be antagonistic with legislation. It is a useful recognition scheme and can positively contribute in promoting safety.

Another type of successful strategy identified was safety promotion. Safety promotion can be successfully achieved via "social marketing". Social marketing can promote more incentive-driven, prevention-oriented concepts. So far incentive systems in Europe are operating based on companies' accident records where premiums are reduced or increased according to safety performances. Social insurance can also play an important role in emphasising and thus rewarding prevention policies.

Besides; safety promotion can be achieved via labelling and certification. Interesting selection and certification schemes for subcontractors exist in Belgium and Germany (European Agency for Safety and Health at Work, 2002).

Life long learning is also a strategy promoted for coping with new work organisation. In European Commission Green Paper (European Commission, 1997) it is stated that "The new forms of work organisation require a much better educated and trained workforce, including in particular, management. The flexibility and adaptability of skills are key. Continuous training and retraining are essential.

However we must ask ourselves which training is sufficient or is occupational health and safety training accessible for all?

It was made evident that workers with precarious work did not have access to occupational health and safety training and therefore life long training obligation is slowly shifting from employers to individuals. This poses a challenge to companies' internal training systems as well as to national educational institutions.

In order to make significant advances in accident prevention; the value of inherent safety must be acknowledged now more than ever. There is a need to shift from assessing existing manufacturing systems to discovering technological alternatives; that is shift from the identification of problems to identification of solutions (Ashford and Zwetsloot, 2000).

The European Commission Green Paper "Partnership for a new organisation of work" (European Commission, 1997) stresses that the challenge is how to develop or adopt policies which support rather than hinder organisational renewal and to strike a productive balance between the interests of business and the interests of workers.

6. Conclusions

There is growing evidence that new work environment can have a negative impact to safety. Downsizing was linked to reduced safety outcomes where lean production industries have higher injury rates. Precarious or atypical workers are more vulnerable to occupational accidents. Existing data also suggest a higher accident rate for migrant workers. However more research is needed into particular aspects of changing work environment and its effects to safety.

Attempts to understand why new work environment would lead in safety deterioration are in their early stages. The author has suggested an underlying mechanism that is based on the intensification of work and lack of resources that could by-pass safety procedures. This mechanism should be tested in future studies to establish a link between intensification and poor safety outcomes. Prevention of occupational accidents is facing new challenges. Policies reviewed in this paper as strengthening the regulation, promotion of certification schemes and training enhancement can help but are fragmentary and cannot solve the problem. Organisations themselves can play a key role in circumventing this negative relationship between new trends and safety.

Work intensity was suggested as a mechanism behind these negative effects. Alternative systems more human-compatible should be promoted to alleviate these effects. Such systems are defined as "sustainable" in the literature. The notion of sustainable systems is borrowed from ecology.

Work intensity refers to the consumption of human resources in work organizations while the sustainable work systems concept presents a vision for the future competitive organizations in which human resources are regenerated and allowed to grow (Docherty et al., 2002).

According to the structuration theory approach (Giddens, 1984), intensity is basically caused by a misfit or imbalance of high demands and prescriptions of work on one hand and inadequately developed rules and recourses in the collective acting of the working on the other. In order to achieve the characteristics of sustainable work systems, a new balance of reasonable demands and available resources has to be found by redescribing work on a higher level (Docherty et al., 2002).

Several strategies could lead to sustainable systems. Group-based self organisation seems to be the cornerstone of a more sustainable work system. The most important aspect of group self-organisation is not autonomy in the classical sense but the extend of resources that are at the disposal of the groups and whether the groups really establish new group-oriented working rules like mutual support or consensual decision making. Another important aspect of sustainability in the organisation of group work is democratic procedures for instance on electing the group spokeperson. Last but not least, a critical parameter of a more sustainable work organisation is the question of how workloads, staffing levels and other targets or rates are set. The new system gives this power directly to the group (Docherty et al., 2002). The new paradigm of sustainable work organizations is not easy to pursue. Moreover practical cases from enterprises applying such models are scarce that could provide insights on the existing barriers against them.

On the other hand the development of sustainable work systems is a logical part of the European debate on forms of work organisation as expressed in the 1997 EU Green Paper on "Partnership for a New Organization of Work". This European vision –competitiveness and sustainable growth through reproduction of recourses – could be offered in contrast to American and Japanese experiences (Eijnatten, 2000).

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10.3 QPS NORDIC 34+ QUESTIONNAIRE (IN GREEK AND ENGLISH)

ΓΕΝΙΚΟ ΕΡΩΤΗΜΑΤΟΛΟΓΙΟ ΓΙΑ ΨΥΧΟΚΟΙΝΩΝΙΚΟΥΣ ΠΑΡΑΓΟΝΤΕΣ ΣΤΗΝ ΕΡΓΑΣΙΑ

*Το ερωτηματολόγιο είναι **ανώνυμο**.*
*Οι απαντήσεις είναι **προαιρετικές**.*

ιπορείτε να μην απαντήσετε σε όποιες ερωτήσεις δεν θεωρείτε σκόπιμο ή δ
έλετε να απαντήσετε. Οι απαντήσεις σας θα βοηθήσουν στον εντοπισμό το
αραγόντων που επηρεάζουν την υγεία και ασφάλεια στον εργασιακό χώρο μ
τόχο τη λήψη μέτρων για τη βελτίωση των συνθηκών εργασίας.

Έκδοση: Σκανδιναβικό Υπουργικό Συμβούλιο* (Nordic Council of Ministers)

Για να απαντήσετε στο Ερωτηματολόγιο

Στις ακόλουθες σελίδες θα βρείτε ερωτήσεις και προτάσεις που περιγράφουν τη δουλειά σας και την επιχείρηση στην οποία εργάζεσθε. Στόχος αυτού του ερωτηματολογίου είναι η συγκέντρωση των απαιτούμενων πληροφοριών για την ανάπτυξη της εργασίας σας και του εργασιακού περιβάλλοντος.

Μη βιαστείτε να απαντήσετε. Βάλτε σε κύκλο την εναλλακτική πρόταση που αντιπροσωπεύει καλύτερα τη γνώμη σας.
Για παράδειγμα:

	Πολύ σπάνια ή ποτέ	Μάλλον σπάνια	Μερικές φορές	Μάλλον συχνά	Πολύ συχνά ή πάντα
1. Πρέπει να βιαστείτε για να τελειώσετε την εργασία σας;	1	2	3	4	5

1. ΠΡΟΣΩΠΙΚΟ ΙΣΤΟΡΙΚΟ

1. Έτος γέννησης ____________
2. Φύλο
   - Άνδρας 1
   - Γυναίκα 2
3. Τίτλος επαγγέλματος

   ____
4. Σε ποιο τμήμα / μονάδα εργάζεσθε;

   ____
5. Έχετε σύμβαση εργασίας
   - Αορίστου χρόνου στην παρούσα επιχείρηση 1
   - Ορισμένου χρόνου 2
6. Είστε εργαζόμενος με σύμβαση;
   - Ναι 1
   - Όχι 2
7. Έχετε θέση επόπτη;
   - Ναι 1
   - Όχι 2

	Πολύ σπάνια <u>ή ποτέ</u>	Μάλλον <u>σπάνια</u>	Μερικές <u>φορές</u>	Μάλλον <u>συχνά</u>	Πολύ συχνά ή <u>πάντα</u>
1. Υπάρχουν διακυμάνσεις στο ωράριο εργασίας σας τέτοιες ώστε να συσσωρεύεται δουλειά;	1	2	3	4	5
2. Έχετε πάρα πολλά να κάνετε;	1	2	3	4	5
3. Είναι τα εργασιακά σας καθήκοντα πολύ δύσκολα για σας;	1	2	3	4	5
4. Εκτελείτε καθήκοντα για τα οποία χρειάζεστε περισσότερη εκπαίδευση;	1	2	3	4	5
5. Αξιοποιούνται οι δεξιότητες και οι γνώσεις σας στην εργασία σας;	1	2	3	4	5
6. Αποτελεί η εργασία σας πρόκληση κατά ένα θετικό τρόπο;	1	2	3	4	5
7. Είναι ξεκάθαρα διατυπωμένος ο σκοπός και οι στόχοι της εργασίας σας;	1	2	3	4	5
8. Γνωρίζετε επακριβώς τι προσδοκίες έχουν από εσάς στην εργασία σας;	1	2	3	4	5
9. Γίνεστε αποδέκτης ασύμβατων απαιτήσεων από δύο ή περισσότερους ανθρώπους;	1	2	3	4	5
10. Μπορείτε να επηρεάσετε τον όγκο της εργασίας που σας ανατίθεται;	1	2	3	4	5
11. Έχετε τη δυνατότητα να καθορίσετε εσείς τον ρυθμό που εργάζεσθε;	1	2	3	4	5
12. Έχετε τη δυνατότητα να αποφασίσετε οι ίδιοι πότε θα κάνετε το διάλειμμά σας;	1	2	3	4	5
13. Έχετε τη δυνατότητα να επηρεάσετε αποφάσεις σημαντικές για την εργασία σας;	1	2	3	4	5
14. Γνωρίζετε εκ των προτέρων τι είδους καθήκοντα σας περιμένουν τον επόμενο μήνα;	1	2	3	4	5
15. Υπάρχουν φήμες που αφορούν αλλαγές στον εργασιακό σας χώρο;	1	2	3	4	5
16. Είσθε ικανοποιημένος με την ικανότητά σας να λύνετε προβλήματα στην εργασία σας;	1	2	3	4	5
17. Εάν χρειαστεί, μπορείτε να έχετε υποστήριξη και βοήθεια στην εργασία σας από συναδέλφους;	1	2	3	4	5

	Πολύ σπάνια ή ποτέ	Μάλλον σπάνια	Μερικές φορές	Μάλλον συχνά	Πολύ συχνά ή πάντα
18. Εάν χρειαστεί, μπορείτε να έχετε υποστήριξη και βοήθεια στην εργασία σας από τον άμεσα προϊστάμενο σας;	1	2	3	4	5
19. Εκτιμά ο άμεσα προϊστάμενος σας τα επιτεύγματά σας στην εργασία;	1	2	3	4	5
20. Σας ενθαρρύνει ο άμεσα προϊστάμενος σας να συμμετέχετε σε σημαντικές αποφάσεις;	1	2	3	4	5
21. Σας βοηθά ο άμεσα προϊστάμενος σας να αναπτύσσετε τις δεξιότητές σας;	1	2	3	4	5
	Πολύ λίγο ή καθόλου	Μάλλον λίγο	Κάπως	Μάλλον πολύ	Πάρα πολύ
22. Αισθάνεστε ότι μπορείτε να βασιστείτε σε φίλους /οικογένεια για υποστήριξη όταν προκύπτουν προβλήματα στην εργασία;	1	2	3	4	5
Πώς είναι το κλίμα στην ομάδα εργασίας σας;	Πολύ λίγο ή καθόλου	Μάλλον λίγο	Κάπως	Μάλλον πολύ	Πάρα πολύ
23. Ενθαρρυντικό και υποστηρικτικό	1	2	3	4	5
24. Χαλαρό και άνετο	1	2	3	4	5
25. Άκαμπτο και βασισμένο σε κανονισμούς	1	2	3	4	5
26. Σας αρέσει το ότι ανήκετε σ' αυτή την ομάδα;	1	2	3	4	5
	Πολύ σπάνια ή ποτέ	Μάλλον σπάνια	Μερικές φορές	Μάλλον συχνά	Πολύ συχνά ή πάντα
27. Λύνει επιτυχώς τα προβλήματα η ομάδα εργασίας σας;	1	2	3	4	5
28. Ενθαρρύνονται οι εργαζόμενοι στον εργασιακό σας χώρο να σκέπτονται τρόπους βελτίωσης της εργασίας;	1	2	3	4	5
29. Υπάρχει επαρκής επικοινωνία στο τμήμα σας;	1	2	3	4	5
30. Έχετε αντιληφθεί ενοχλητικές αντιπαραθέσεις μεταξύ συναδέλφων;	1	2	3	4	5

	Πολύ σπάνια ή ποτέ	Μάλλον σπάνια	Μερικές φορές	Μάλλον συχνά	Πολύ συχνά ή πάντα
31. Ελέγχεται η απόδοσή σας ηλεκτρονικά;	1	2	3	4	5
		ΝΑΙ		***ΟΧΙ***	
32. Έχετε ενημερωθεί για τον τρόπο ελέγχου;		1		2	
33. Σας συμβουλεύτηκαν κατά την εισαγωγή του συστήματος ελέγχου;		1		2	
34. Έλαβαν υπόψη τις παρατηρήσεις σας;		1		2	
35. Είναι οι άμεσα προϊστάμενοι σας εκπαιδευμένοι να κρίνουν την απόδοση σας βάσει κάποιου προδιαγεγραμμένου τρόπου δίκαια και εχέμυθα;		1		2	
	Πολύ σπάνια ή ποτέ	Μάλλον σπάνια	Μερικές φορές	Μάλλον συχνά	Πολύ συχνά ή πάντα
36. Είναι εφικτή η επίτευξη στόχων;	1	2	3	4	5
	Πολύ λίγο ή καθόλου	Μάλλον λίγο	Κάπως	Μάλλον πολύ	Πάρα πολύ
37. Έχετε παρατηρήσει να μην αντιμετωπίζονται ισότιμα οι άνδρες και οι γυναίκες στον εργασιακό σας χώρο;	1	2	3	4	5
38. Έχετε παρατηρήσει να μην αντιμετωπίζονται ισότιμα οι παλιότεροι και οι νέοι εργαζόμενοι στον εργασιακό σας χώρο;	1	2	3	4	5
39. Ανταμείβεστε (χρήματα, ενθάρρυνση) όταν κάνετε μια δουλειά πολύ καλά στην εταιρεία σας;	1	2	3	4	5
40. Σε τι βαθμό ενδιαφέρεται η διοίκηση της εταιρείας σας για την υγεία και την ευεξία των εργαζομένων;	1	2	3	4	5
		ΝΑΙ		ΟΧΙ	
41. Υπάρχει συγκεκριμένη πολιτική της εταιρείας όσον αφορά τη βία που σχετίζεται με την εργασία που περιλαμβάνει λεκτική προσβολή;		1		2	
42. Υπάρχουν σαφείς διαδικασίες που θα πρέπει να ακολουθούν οι εργαζόμενοι όταν ένας πελάτης γίνεται υβριστικός/προσβλητικός;		1		2	

	Διαφωνώ απόλυτα	Διαφωνώ έως ένα βαθμό	Αδιάφορο	Συμφωνώ έως ένα βαθμό	Συμφωνώ απόλυτα
43. Μου αρέσει να με απορροφά αντικείμενο της εργασίας μου το μεγαλύτερο μέρος του χρόνου	1	2	3	4	5
44. Η μεγαλύτερη ικανοποίηση στη ζωή μου προέρχεται από την εργασία μου	1	2	3	4	5
Άγχος χαρακτηρίζεται η κατάσταση κατά την οποία το άτομο αισθάνεται ένταση, ανησυχία, νευρικότητα, αγωνία, ή έχει βραδινές αϋπνίες λόγω της αδιάλειπτης συγκέντρωσης του μυαλού του σε προβλήματα	Καθόλου	Λίγο	Έως ένα βαθμό	Μάλλον αρκετά	Πάρα πολύ
45. Αισθάνεστε αυτού το είδος το άγχος τις τελευταίες ημέρες;	1	2	3	4	5

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Responding to the Questionnaire

On the following pages you will find questions and statements about your work and the organization where you work. The purpose of this questionnaire form is to collect the information needed to develop your work and the work environment.

Take your time answering. Answers to most of the questions are given by circling the alternative that best describes your opinion. For example:

		Very seldom /never	Rather seldom	Some-times	Rather often	Very often or always
1.	Do you have to hurry to get your work done?	1	2	3	4	5

PERSONAL BACKGROUND

Al. Year of birth

A2. Sex
Male.... 1
Female. 2

A3. Title of occupation

A4. In what department / section / unit do you work?

A5. Is your employment contract
Permanent at the present organization 1
Temporary 2

A6. Are you a contract worker?
Yes........................ 1
No.........................2

A7. Is your job a supervisory position?
Yes........................ 1
No.........................2

	Very seldom or never	Rather seldom	Some-times	Rather often	Very often or always
Is your work load irregular so that the work piles up?	1	2	3	4	5
Do you have too much to do?	1	2	3	4	5
Are your work tasks too difficult for you?	1	2	3	4	5
Do you perform work tasks for which you need more training?	1	2	3	4	5
Are your skills and knowledge useful in your work?	1	2	3	4	5
Is your work challenging in a positive way"?	1	2	3	4	5
Have clear, planned goals and objectives been defined for your job?	1	2	3	4	5
Do you know exactly what is expected of you at work'?	1	2	3	4	5
Do you receive incompatible requests from two or more people?	1	2	3	4	5
Can you influence the amount of work assigned to you?	1	2	3	4	5
Can you set your own work pace?	1	2	3	4	5
Can you decide yourself when you are going to take a break?	1	2	3	4	5
Can you influence decisions that are important for your work?	1	2	3	4	5
Do you know in advance what kind of tasks to expect a month from now'?	1	2	3	4	5
Are there rumors concerning changes at your workplace?	1	2	3	4	5
Are you content with your ability to solve problems at work"?	1	2	3	4	5
If needed, can you get support and help with your work from your coworkers?	1	2	3	4	5
If needed, can you get support and help with your work from your immediate superior"?	1	2	3	4	5
Are your work achievements appreciated by your immediate superior?	1	2	3	4	5
Does your immediate superior encourage you to participate in important decisions'?	1	2	3	4	5
Does your immediate superior help you develop your skills?	1	2	3	4	5

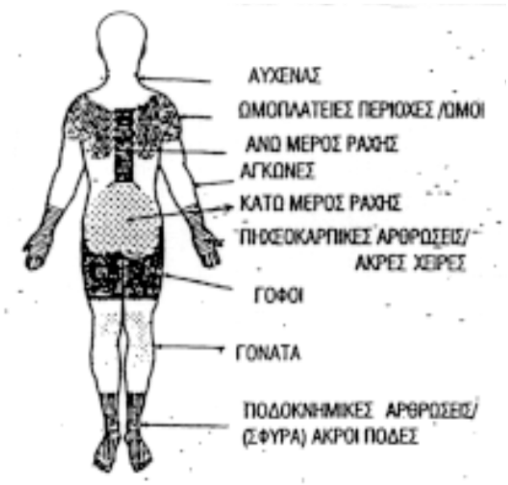
	Very little or not at all	Rather little	Some-what	Rather much	Very much
Do you feel that your friends / family can be relied for support when things get tough at work"?	1	2	3	4	5
What is the climate like in your work unit?	Very little or not at all	Rather little	Some-what	Rather much	Very much
Encouraging and supportive	1	2	3	4	5
Relaxed and comfortable	1	2	3	4	5
Rigid and rule-based	1	2	3	4	5
Do you appreciate belonging to your work group or team?	1	2	3	4	5
	Very seldom or never	Rather seldom	Some-times	Rather often	Very often or always
Is your group or team successful at problem solving?	1	2	3	4	5
Are workers encouraged to think of ways to do things better at your workplace'-'	1	2	3	4	5
Is there sufficient communication in your department?	1	2	3	4	5
Have you noticed any disturbing conflicts between co workers'?	1	2	3	4	5
	Very seldom or never	Rather seldom	Some-times	Rather often	Very often or always
Is your performance controlled electronically?	1	2	3	4	5
		YES		NO	
Have you been informed for the way of control?		YES		NO	
Have you been consulted?		YES		NO	
Your observations were taken into account		YES		NO	
Are your supervisors trained to judge your performance in a fair way?		YES		NO	
Are quantitative targets achievable?	Very seldom or never 1	Rather seldom 2	Some-times 3	Rather often 4	Very often or always 5
	Very seldom or never 1	Rather seldom 2	Some-times 3	Rather often 4	Very often or always 5
Have you noticed any inequalities in how men and women are treated at your workplace"?	1	2	3	4	5
Have you noticed any inequalities in how older and younger employees are treated at your workplace?	1	2	3	4	5
At your organization, are you rewarded (money, encouragement) for a job well done"?	1	2	3	4	5
To what extent is the management of your organization interested in the health and well-being of the personnel"?	1	2	3	4	5

	Disagree totally	Disagree to some extent	Indif-ferent	Agree to some extent	Agree totally
I like to be absorbed in my job most of the time	1	2	3	4	5
The major satisfaction in my life comes from my Job	1	2	3	4	5
	Not at all	Only a little	To some extent	Rather much	Very much
Stress means the situation when a per son feels tense, restless, nervous, or anxious, or is unable to sleep at night because his or her mind is troubled all the time. Do you feel that kind of stress these days'?	1	2	3	4	5

10.4 MSD QUESTIONNAIRE (IN GREEK & ENGLISH)

ΕΝΟΧΛΗΜΑΤΑ ΑΠΟ ΤΟ ΜΥΟΣΚΕΛΕΤΙΚΟ ΣΥΣΤΗΜΑ

ΕΤΟΣ ΓΕΝΝΗΣΗΣ 19_ _ ΑΝΔΡΑΣ ☐ ΓΥΝΑΙΚΑ ☐ ΑΥΞ. ΑΡΙΘΜΟΣ



Αυτή η εικόνα δείχνει κατά προσέγγιση, τη θέση εκείνη των περιοχών του σώματος που αναφέρονται στο ερωτηματολόγιο. Θα πρέπει μόνος σας να αναφέρετε σε ποια περιοχή του σώματός σας εντοπίζονται τα πιθανά ενοχλήματά σας.

Επί πόσα χρόνια και μήνες έχετε τις τωρινές εργασιακές σας δραστηριότητες; 1 ___ 2 Χρόνια + 3 ___ 4 μήνες

Πόσο είναι το εβδομαδιαίο ωράριό σας κατά μέσο όρο; 5 ___ 6 ώρες

Πόσο ζυγίζετε; 7 ___ 9 Kg

Τι ύψος έχετε; 10 ___ 12 cm

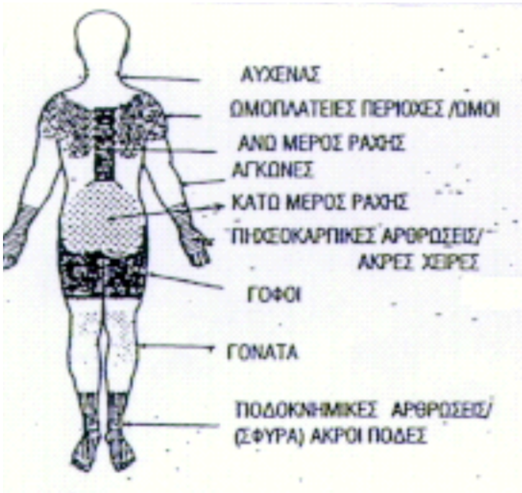
[13] 1 Δεξιόχειρας 2 Αριστερόχειρας

Οι παρακάτω ερωτήσεις να απαντηθούν από όλους	Οι παρακάτω ερωτήσεις να απαντηθούν μόνο από όσους έχουν δηλώσει ότι έχουν τα αντίστοιχα ενοχλήματα της αριστερής στήλης	
Είχατε ποτέ ενοχλήματα (πόνος τοπικός ή διάχυτος, δυσφορία τους τελευταίους 12 μήνες στο/στα:	Σας έτυχε ποτέ τους τελευταίους 12 μήνες να μην μπορείτε να βγάλετε εις πέρας την εργασία σας (μέσα και έξω από το σπίτι λόγω των ενοχλημάτων) ;	Είχατε καθόλου ενοχλήματα τα τελευταία 7 εικοσιτετράωρα;
[14] **ΑΥΧΕΝΑ** 1 Όχι 2 Ναι	[15] 1 Όχι 2 Ναι	[16] 1 Όχι 2 Ναι
[17] **ΩΜΟΠΛΑΤΕΣ ΠΕΡΙΟΧΕΣ / ΩΜΟΥΣ** 1 Όχι 2 Ναι, στη δεξιά ωμοπλατιαία περιοχή /ώμο 3 Ναι, στην αριστερή ωμοπλατιαία περιοχή / ώμο 4 Ναι, και στις δύο ωμοπλατιαίες περιοχές / ώμους	[18] 1 Όχι 2 Ναι	[19] 1 Όχι 2 Ναι
[20] **ΑΓΚΩΝΕΣ** 1 Όχι 2 Ναι, στο δεξιό αγκώνα 3 Ναι, στον αριστερό αγκώνα 4 Ναι, και στους δύο αγκώνες	[21] 1 Όχι 2 Ναι	[22] 1 Όχι 2 Ναι
[23] **ΩΜΟΠΛΑΤΕΣ ΠΕΡΙΟΧΕΣ / ΩΜΟΥΣ** 1 Όχι 2 Ναι, στη δεξιά άρθρωση / άκρα χείρα 3 Ναι, στην αριστερή άρθρωση / άκρα χείρα 4 Ναι, και στις δύο αρθρώσεις / άκρες χείρες	[24] 1 Όχι 2 Ναι	[25] 1 Όχι 2 Ναι
[26] **ΑΝΩ ΜΕΡΟΣ ΡΑΧΗΣ (θωρακική περιοχή)** 1 Όχι 2 Ναι	[27] 1 Όχι 2 Ναι	[28] 1 Όχι 2 Ναι
[29] **ΑΝΩ ΜΕΡΟΣ ΡΑΧΗΣ (οσφυική/ιερή περιοχή)** 1 Όχι 2 Ναι	[30] 1 Όχι 2 Ναι	[31] 1 Όχι 2 Ναι
[32] **ΕΝΑ ΓΟΦΟ ή ΚΑΙ ΣΤΟΥΣ ΔΥΟ ΓΟΦΟΥΣ** 1 Όχι 2 Ναι	[33] 1 Όχι 2 Ναι	[34] 1 Όχι 2 Ναι
[35] **ΕΝΑ ΓΟΝΑΤΟ ή ΚΑΙ ΣΤΑ ΔΥΟ ΓΟΝΑΤΑ** 1 Όχι 2 Ναι	[36] 1 Όχι 2 Ναι	[37] 1 Όχι 2 Ναι
[38] **ΜΙΑ ΠΟΔΟΚΝΗΜΙΚΗ ΑΡΘΡΩΣΗ /άκρο πόδι ή ΚΑΙ ΣΤΙΣ ΔΥΟ ΠΟΔΟΚΝΗΜΙΚΕΣ ΑΡΘΡΩΣΕΙΣ /άκρα πόδια** 1 Όχι 2 Ναι	[39] 1 Όχι 2 Ναι	[40] 1 Όχι 2 Ναι

Μεταφορά στα ελληνικά: Αντωνοπούλου Μ., Ekdahl C., Σγάντζος Μ., Αντωνάκης Ν. και Αλιώνης Χ.
Κλινική Κοινωνικής και Οικογενειακής Ιατρικής του Τμήματος Ιατρικής του Πανεπιστημίου Κρήτης

TROUBLES WITH THE MUSCULOSKELETAL SYSTEM

YEAR OF BIRTH 19_ _	MALE ☐	FEMALE ☐	NUMBER



In this picture you can see the approximate position of the part of the body referred to in the questionnaire. Please answer by putting a cross in the appropriate box.

How many years and moths have you been doing your present work? 1 2 Years + 3 4 months

On average how many hours a week you work? 5 6 hours

How much do you weigh? 7 9 Kg

How tall are you? 10 12 cm

13 1 Right-handed 2 Left-handed

	To be answered only by those who have had trouble	
Have you at any time during the last **12 months** had trouble (ache, pain, discomfort) in:	Have you at any time during the last **12 months been prevented from doing** your normal work because of the trouble?	Have you had trouble at any time **during the last 7 days?**
14 **NECK** 1 No 2 Yes	15 1 No 2 Yes	16 1 No 2 Yes
17 **SHOULDERS** 1 No 2 Yes, in the right shoulder 3 Yes, in the left shoulder 4 Yes, in both shoulders	18 1 No 2 Yes	19 1 No 2 Yes
20 **ELBOWS** 1 No 2 Yes, in right elbow 3 Yes, in left elbow 4 Yes, in both elbows	21 1 No 2 Yes	22 1 No 2 Yes
23 **WRISTS/HANDS** 1 No 2 Yes, in right wrist/hand 3 Yes, in left wrist/hand, 4 Yes, in both wrists/hands	24 1 No 2 Yes	25 1 No 2 Yes
26 **UPPER BACK** 1 No 2 Yes	27 1 No 2 Yes	28 1 No 2 Yes
29 **LOWER BACK** 1 No 2 Yes	30 1 No 2 Yes	31 1 No 2 Yes
32 **ONE OR BOTH HIPS/THIGHS** 1 No 2 Yes	33 1 No 2 Yes	34 1 No 2 Yes
35 **ONE OR BOTH KNEES** 1 No 2 Yes	36 1 No 2 Yes	37 1 No 2 Yes
38 **ONE OR BOTH ANKLES/FEET** 1 No 2 Yes	39 1 No 2 Yes	40 1 No 2 Yes

10.5 OVERVIEW OF THE FIELD STUDY

10.5.1: Case studies and level of lean application

	Manufacturing			Services
	GREECE		*UK*	*GREECE*
	Metal industry	*Beverage Industry*	Electronics	*Call centers*
Number of employees in lean production departments	**350**	**100**[9]	**250**	**500**
Lean characteristics[10]				
Set up reduction	✔	✔	✔	-
Inventory and waste reduction (Kanban Pull signals)	*some*	*little*	✔	✔
Supplier partnerships	*some*		✔	
Continuous Improvement Program	✔	✔	✔	✔
Mixed-Model production / (Continuous flow – Cellular production)	-	-	✔	✔
Total Quality Management	✔	✔	✔	✔
Mistake proof (poka-yoke)	✔	✔		✔
Total Preventive Maintenance	✔	*some*	✔	
Standard Operating Procedures (SOP)		✔	✔	✔
TOTAL	**FAIR 3,6**	**MODERATE 2,4**	**ADVANCED 5**	**FAIR 3,5**

10.5.2: Field work overview

FIELD STUDY	*COMPANIES*				
	Manufacturing			*Services*	
	GREECE		UK	GREECE	
	Metal industry	Beverage Industry	Electronics	Call centres	
				Public	Multinational
Psychosocial					
Distributed	100	100	100	200	
Returned	24	29	12	116	
Response rate	24	29	12	58	
TOTAL SECTOR	**65**		***22%***	**116**	***58%***
MSD					
Distributed		100		100	200
Returned		26		38	172
Response rate		26		38	86
TOTAL SECTOR	**26**	***26%***		**210**	***70%***
TOTAL	**PSY**	**181**	***36.2%***	**MSD**	**236**
				MSD	***59%***

Total people responded in both questionnaires: 353

10.6 STATISTICAL ANALYSIS

NOTE: *IN THE APPENDIX SPSS TABLES ARE ILLUSTRATED. THE SPSS USED FOR THE STATISTICAL ANALYSIS IN THIS THESIS IS USING BY DEFAULT THE GREEK DECIMAL SYSTEM WITH COMMA (,) INSTEAD OF THE DECIMAL POINT (.). (FOR EXAMPLE IT IS p=0,05 INSTEAD OF p=0.05).*

10.6.1 Demographics (Call centres and Manufacturing)

		Company					
		CALL CENTRE 1	CALL CENTRE 2	BEVERAGE COMPANY	METAL COMPANY	ELECTRONICS	Total
SEXFINAL	MALE	31	46	13	23	9	122
	FEMALE	85	126	0	1	2	214
	UNKNOWN	0	0	16	0	1	17
Total		116	172	29	24	12	353

			q45_	q39_	q40_	q41	q42_	q43_	q44_	Q1_Q2	Q3_Q4	Q5_Q6	Q7_Q8
Spearman's rho	q45_	Correlation Coefficient	1,000	,090	-,148	,007	-,063	,244*	,045	,295**	,375**	,103	-,119
		Sig. (2-tailed)	.	,357	,127	,946	,513	,011	,642	,002	,000	,278	,212
		N	112	108	108	100	110	108	109	110	112	112	111
	q39_	Correlation Coefficient	,090	1,000	,187	-,131	-,271**	,244*	,223*	,032	,104	,336**	,148
		Sig. (2-tailed)	,357	.	,055	,198	,005	,012	,022	,741	,280	,000	,128
		N	108	109	106	98	108	105	105	107	109	109	108
	q40_	Correlation Coefficient	-,148	,187	1,000	-,388**	-,365**	-,116	,225*	,069	-,082	,084	,197*
		Sig. (2-tailed)	,127	,055	.	,000	,000	,239	,021	,478	,399	,385	,041
		N	108	106	109	98	107	105	105	107	109	109	108
	q41_	Correlation Coefficient	,007	-,131	-,388**	1,000	,462**	,080	,060	,013	-,010	-,084	-,018
		Sig. (2-tailed)	,946	,198	,000	.	,000	,432	,557	,899	,918	,408	,859
		N	100	98	98	100	100	98	97	99	100	100	100
	q42_	Correlation Coefficient	-,063	-,271**	-,365**	,462**	1,000	-,081	,040	,097	,000	-,209*	-,084
		Sig. (2-tailed)	,513	,005	,000	,000	.	,404	,679	,315	1,000	,028	,381
		N	110	108	107	100	111	108	108	109	111	111	110
	q43_	Correlation Coefficient	,244*	,244*	-,116	,080	-,081	1,000	,349**	-,058	,121	,286**	,080
		Sig. (2-tailed)	,011	,012	,239	,432	,404	.	,000	,550	,209	,003	,410
		N	108	105	105	98	108	109	106	108	109	109	109
	q44_	Correlation Coefficient	,045	,223*	,225*	,060	,040	,349**	1,000	,020	,025	,275**	,205*
		Sig. (2-tailed)	,642	,022	,021	,557	,679	,000	.	,834	,794	,004	,032
		N	109	105	105	97	108	106	110	108	110	110	109

Q1_Q2	Correlation Coefficient	,295**	,032	,069	,013	,097	-,058	,020	1,000	,320**	,028	-,105
	Sig. (2-tailed)	,002	,741	,478	,899	,315	,550	,834	.	,001	,771	,272
	N	110	107	107	99	109	108	108	114	113	112	111
Q3_Q4	Correlation Coefficient	,375**	,104	-,082	-,010	,000	,121	,025	,320**	1,000	,147	-,286**
	Sig. (2-tailed)	,000	,280	,399	,918	1,000	,209	,794	,001	.	,120	,002
	N	112	109	109	100	111	109	110	113	115	114	113
Q5_Q6	Correlation Coefficient	,103	,336**	,084	-,084	-,209*	,286**	,275**	,028	,147	1,000	,143
	Sig. (2-tailed)	,278	,000	,385	,408	,028	,003	,004	,771	,120	.	,131
	N	112	109	109	100	111	109	110	112	114	114	113
Q7_Q8	Correlation Coefficient	-,119	,148	,197*	-,018	-,084	,080	,205*	-,105	-,286**	,143	1,000
	Sig. (2-tailed)	,212	,128	,041	,859	,381	,410	,032	,272	,002	,131	.
	N	111	108	108	100	110	109	109	111	113	113	113

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

10.6.2 Correlation table for Job stress and Psychosocial factors (Call centres), 1

Correlations

			q45_PYSOC	Q10_Q13	Q11_Q12	Q18_Q19	Q20_Q21	Q23_Q24_Q25	Q26_Q27	Q28_Q29
Spearman's rho	q45_	Correlation Coefficient	1,000	,043	-,304**	-,047	-,008	-,232*	-,229*	-,224*
		Sig. (2-tailed)	.	,658	,001	,626	,936	,014	,017	,020
		N	112	110	112	112	104	111	108	108
	Q10_Q13	Correlation Coefficient	,043	1,000	,419**	,176	,239*	-,191*	-,014	,141
		Sig. (2-tailed)	,658	.	,000	,064	,014	,044	,887	,145
		N	110	113	113	112	105	111	109	108
	Q11_Q12	Correlation Coefficient	-,304**	,419**	1,000	,240*	,214*	,122	,178	,173
		Sig. (2-tailed)	,001	,000	.	,010	,027	,197	,063	,073
		N	112	113	115	114	106	113	110	109
	Q18_Q19	Correlation Coefficient	-,047	,176	,240*	1,000	,411**	,160	,428**	,376**
		Sig. (2-tailed)	,626	,064	,010	.	,000	,090	,000	,000
		N	112	112	114	114	106	113	110	109
	Q20_Q21	Correlation Coefficient	-,008	,239*	,214*	,411**	1,000	-,001	,203*	,369**
		Sig. (2-tailed)	,936	,014	,027	,000	.	,995	,038	,000
		N	104	105	106	106	106	105	104	103
	Q23_Q24_Q25	Correlation Coefficient	-,232*	-,191*	,122	,160	-,001	1,000	,440**	,211*
		Sig. (2-tailed)	,014	,044	,197	,090	,995	.	,000	,028
		N	111	111	113	113	105	113	109	108
	Q26_Q27	Correlation Coefficient	-,229*	-,014	,178	,428**	,203*	,440**	1,000	,574**

		Sig. (2-tailed)	,017	,887	,063	,000	,038	,000	.	,000
		N	108	109	110	110	104	109	110	107
	Q28_Q29	Correlation Coefficient	-,224*	,141	,173	,376**	,369**	,211*	,574**	1,000
		Sig. (2-tailed)	,020	,145	,073	,000	,000	,028	,000	.
		N	108	108	109	109	103	108	107	109

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

10.6.2 Correlation table for Job stress and Psychosocial factors (Call centres), 2

Correlations

			q45_PYSOC	Q43_Q44	Q17_Q18_Q19	Q37_Q38	Q39_Q40
Spearman's rho	q45_PYSOC	Correlation Coefficient	1,000	,175	-,115	-,005	-,025
		Sig. (2-tailed)	.	,066	,229	,954	,798
		N	112	112	112	112	111
	Q43_Q44	Correlation Coefficient	,175	1,000	,213*	-,037	,256**
		Sig. (2-tailed)	,066	.	,023	,696	,007
		N	112	113	113	113	111
	Q17_Q18_Q19	Correlation Coefficient	-,115	,213*	1,000	-,404**	,342**
		Sig. (2-tailed)	,229	,023	.	,000	,000
		N	112	113	114	114	112
	Q37_Q38	Correlation Coefficient	-,005	-,037	-,404**	1,000	-,145
		Sig. (2-tailed)	,954	,696	,000	.	,128
		N	112	113	114	114	112
	Q39_Q40	Correlation Coefficient	-,025	,256**	,342**	-,145	1,000
		Sig. (2-tailed)	,798	,007	,000	,128	.
		N	111	111	112	112	112

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

10.6.2 Correlation table for Job stress and Psychosocial factors (Call centres), 3

Correlations

			q45_	q1_	q2_	q3_	q4_	q5_	q6_	q7_	q8_	q9P	q10_
Spearman's rho	q45_	Correlation Coefficient	1,000	,275**	,171	,240*	,363**	,083	,145	-,141	-,094	,327**	,168
		Sig. (2-tailed)	.	,004	,077	,012	,000	,384	,129	,139	,327	,001	,088
		N	112	106	108	109	111	111	111	111	110	106	104
	q1_	Correlation Coefficient	,275**	1,000	,081	,033	,182	,061	,228*	,016	,065	,395**	,138
		Sig. (2-tailed)	,004	.	,410	,737	,060	,536	,017	,869	,503	,000	,166
		N	106	110	106	108	107	107	108	108	107	104	103
	q2_	Correlation Coefficient	,171	,081	1,000	,367**	,277**	-,014	,020	-,119	-,211*	,290**	,148
		Sig. (2-tailed)	,077	,410	.	,000	,004	,885	,839	,216	,028	,003	,133
		N	108	106	110	108	108	108	110	109	108	106	104
	q3_PYSOC	Correlation Coefficient	,240*	,033	,367**	1,000	,388**	,186	,124	-,300**	-,189*	,379**	,124
		Sig. (2-tailed)	,012	,737	,000	.	,000	,053	,196	,001	,048	,000	,206
		N	109	108	108	112	110	109	111	110	110	107	105
	q4_PYSOC	Correlation Coefficient	,363**	,182	,277**	,388**	1,000	,051	,179	-,223*	-,200*	,343**	,126
		Sig. (2-tailed)	,000	,060	,004	,000	.	,592	,061	,018	,036	,000	,199
		N	111	107	108	110	113	111	111	111	110	106	105

	q5_PYSOC	Correlation Coefficient	,083	,061	-,014	,186	,051	1,000	,531**	,091	,190*	,108	,234*
		Sig. (2-tailed)	,384	,536	,885	,053	,592	.	,000	,342	,045	,270	,017
		N	111	107	108	109	111	112	111	112	111	106	104
	q6_PYSOC	Correlation Coefficient	,145	,228*	,020	,124	,179	,531**	1,000	,098	,133	,136	,256**
		Sig. (2-tailed)	,129	,017	,839	,196	,061	,000	.	,302	,165	,160	,008
		N	111	108	110	111	111	111	113	112	111	108	105
	q7_PYSOC	Correlation Coefficient	-,141	,016	-,119	-,300**	-,223*	,091	,098	1,000	,605**	-,222*	-,236*
		Sig. (2-tailed)	,139	,869	,216	,001	,018	,342	,302	.	,000	,021	,015
		N	111	108	109	110	111	112	112	113	112	107	105
	q8_PYSOC	Correlation Coefficient	-,094	,065	-,211*	-,189*	-,200*	,190*	,133	,605**	1,000	-,023	-,147
		Sig. (2-tailed)	,327	,503	,028	,048	,036	,045	,165	,000	.	,818	,137
		N	110	107	108	110	110	111	111	112	112	106	104
	q9_PYSOC	Correlation Coefficient	,327**	,395**	,290**	,379**	,343**	,108	,136	-,222*	-,023	1,000	,265**
		Sig. (2-tailed)	,001	,000	,003	,000	,000	,270	,160	,021	,818	.	,007
		N	106	104	106	107	106	106	108	107	106	108	101
	q10_PYSOC	Correlation Coefficient	,168	,138	,148	,124	,126	,234*	,256**	-,236*	-,147	,265**	1,000
		Sig. (2-tailed)	,088	,166	,133	,206	,199	,017	,008	,015	,137	,007	.

N	104	103	104	105	105	104	105	105	104	101	107

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

10.6.2 Correlation table for Job stress and Psychosocial factors (Call centres), 4

Correlations

			q45_	q11_	q12_	q13_	q14_	q15_	q16_	q17_	q18_	q19_	q20_
Spearman's rho	q45_PYSOC	Correlation Coefficient	1,000	-,062	-,384**	-,206*	-,307**	,315**	-,024	-,216*	-,110	,019	-,043
		Sig. (2-tailed)	.	,521	,000	,032	,001	,001	,810	,022	,253	,852	,670
		N	112	110	111	109	107	106	106	112	110	104	100
	q11_PYSOC	Correlation Coefficient	-,062	1,000	,035	,250**	-,168	,219*	,089	,058	,116	,237*	,276**
		Sig. (2-tailed)	,521	.	,714	,008	,080	,023	,362	,541	,229	,015	,005
		N	110	113	111	110	109	107	106	112	110	104	100
	q12_PYSOC	Correlation Coefficient	-,384**	,035	1,000	,190*	,152	-,146	-,026	,132	,274**	,118	,076
		Sig. (2-tailed)	,000	,714	.	,046	,115	,132	,792	,165	,004	,231	,452
		N	111	111	113	111	109	108	107	113	111	105	101
	q13_PYSOC	Correlation Coefficient	-,206*	,250**	,190*	1,000	-,075	,089	-,119	,035	,125	,128	,288**
		Sig. (2-tailed)	,032	,008	,046	.	,442	,362	,225	,714	,195	,193	,004
		N	109	110	111	111	108	106	106	111	109	105	100
	q14_PYSIC	Correlation Coefficient	-,307**	-,168	,152	-,075	1,000	-,290**	,068	,189*	,179	,122	-,132
		Sig. (2-tailed)	,001	,080	,115	,442	.	,002	,493	,049	,064	,222	,191

	N	107	109	109	108	109	107	105	109	108	102	100
q15_PYSOC	Correlation Coefficient	,315**	,219*	-,146	,089	-,290**	1,000	-,102	-,377**	-,149	,005	,178
	Sig. (2-tailed)	,001	,023	,132	,362	,002	.	,300	,000	,125	,960	,080
	N	106	107	108	106	107	108	106	108	107	100	98
q16_PYSOC	Correlation Coefficient	-,024	,089	-,026	-,119	,068	-,102	1,000	,223*	,162	,213*	-,002
	Sig. (2-tailed)	,810	,362	,792	,225	,493	,300	.	,021	,098	,032	,983
	N	106	106	107	106	105	106	107	107	105	101	97
q17_PYSOC	Correlation Coefficient	-,216*	,058	,132	,035	,189*	-,377**	,223*	1,000	,529**	,187	-,116
	Sig. (2-tailed)	,022	,541	,165	,714	,049	,000	,021	.	,000	,056	,250
	N	112	112	113	111	109	108	107	114	112	105	101
q18_PYSOC	Correlation Coefficient	-,110	,116	,274**	,125	,179	-,149	,162	,529**	1,000	,416**	,160
	Sig. (2-tailed)	,253	,229	,004	,195	,064	,125	,098	,000	.	,000	,111
	N	110	110	111	109	108	107	105	112	112	103	101
q19_PYSOC	Correlation Coefficient	,019	,237*	,118	,128	,122	,005	,213*	,187	,416**	1,000	,434**
	Sig. (2-tailed)	,852	,015	,231	,193	,222	,960	,032	,056	,000	.	,000
	N	104	104	105	105	102	100	101	105	103	105	99
q20_PYSOC	Correlation Coefficient	-,043	,276**	,076	,288**	-,132	,178	-,002	-,116	,160	,434**	1,000

	Sig. (2-tailed)	,670	,005	,452	,004	,191	,080	,983	,250	,111	,000	.
	N	100	100	101	100	100	98	97	101	101	99	101

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

10.6.2 Correlation table for Job stress and Psychosocial factors (Call centres), 5

10.6.3 Control of statistically significant differences between job stress and performance monitoring (call centres)

Case Summaries

q45_Job stress

q32_PYSOC		N	Mean	Median	Minimum	Maximum	Std. Deviation
dimen men- sion1	1 yes	55	2,49	2,00	1 not at all	5 very much	1,413
	2 no	53	2,96	3,00	1 not at all	5 very much	1,330
	Total	108	2,72	3,00	1 not at all	5 very much	1,386

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	1169,000
Wilcoxon W	2709,000
Z	-1,816
Asymp. Sig. (2-tailed)	,069

a. Grouping Variable: q32_PYSOC: Information on the performance monitoring

Case Summaries

q45_Job stress

q33_Job stress		N	Mean	Median	Minimum	Maximum	Std. Deviation
dimen men- sion1	1 yes	3	4,33	5,00	3 to some extend	5 very much	1,155
	2 no	105	2,69	3,00	1 not at all	5 very much	1,368
	Total	108	2,73	3,00	1 not at all	5 very much	1,385

Test Statistics[b]

	q45_Job stress
Mann-Whitney U	56,000
Wilcoxon W	5621,000
Z	-1,943
Asymp. Sig. (2-tailed)	,052
Exact Sig. [2*(1-tailed Sig.)]	,057[a]

a. Not corrected for ties.
b. Grouping Variable: q33_PYSOC: Consultation during the performance monitoring

Case Summaries

q45_Job stress

q34_PYSOC		N	Mean	Median	Minimum	Maximum	Std. Deviation
dimen men- sion1	1 yes	7	3,43	4,00	1 not at all	5 very much	1,272
	2 no	94	2,76	3,00	1 not at all	5 very much	1,373
	Total	101	2,80	3,00	1 not at all	5 very much	1,371

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	236,500
Wilcoxon W	4701,500
Z	-1,265
Asymp. Sig. (2-tailed)	,206

a. Grouping Variable: q34_PYSOC: Comments taken into account

Case Summaries

q45_Job stress

q35_PYSOC		N	Mean	Median	Minimum	Maximum	Std. Deviation
dimen men- sion1	1 ναι	66	2,80	3,00	1 not at all	5 very much	1,438
	2 όχι	36	2,67	3,00	1 not at all	5 very much	1,309
	Total	102	2,75	3,00	1 not at all	5 very much	1,389

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	1128,000
Wilcoxon W	1794,000
Z	-,430
Asymp. Sig. (2-tailed)	,667

a. Grouping Variable: q35_PYSOC: Are your immediate superiors trained to judge your performance on a prede-scribed way, fair and confidentially?

10.6.4 Correlation table for Job satisfaction and Psychosocial factors (Call centres)

Correlations

			Q43_Q44	Q1_Q2	Q3_Q4	Q5_Q6	Q7_Q8	q9_PYSOC	Q10_Q13	Q11_Q12	q14_PYSIC	q16_PYSOC	q17_PYSOC	Q18_Q19	Q20_Q21	q22_PYSOC	Q23_Q24_Q25	Q26_Q27	Q28_Q29	q30_PYSOC	q31_PYSOC	q36_PYSOC
Spearman's rho	Q43_Q44	Correlation Coefficient	1,000	-,025	,073	,342**	,183	,137	,294**	,073	,052	,069	,038	,243**	,228*	-,092	-,075	,055	,125	-,006	,010	,079
		Sig. (2-tailed)	.	,793	,442	,000	,054	,160	,002	,441	,594	,484	,690	,009	,019	,351	,431	,571	,196	,947	,914	,444
		N	113	111	113	113	112	107	111	113	108	106	113	113	105	105	112	109	108	110	109	97
	Q1_Q2	Correlation Coefficient	-,025	1,000	,320**	,028	-,105	,486**	,121	-,019	-,260**	,032	-,075	,016	,053	,047	-,086	,054	-,103	,222*	-,003	,271**
		Sig. (2-tailed)	,793	.	,001	,771	,272	,000	,204	,843	,007	,744	,429	,866	,589	,635	,371	,579	,285	,019	,972	,007
		N	111	114	113	112	111	107	112	113	108	105	112	112	105	105	111	108	109	111	108	97
	Q3_Q4	Correlation Coefficient	,073	,320**	1,000	,147	-,286**	,420**	,146	,010	-,326**	-,109	-,158	-,085	,193*	,030	-,156	-,016	-,035	,398**	,042	,053
		Sig. (2-tailed)	,442	,001	.	,120	,002	,000	,123	,914	,001	,266	,094	,371	,047	,759	,099	,869	,716	,000	,663	,604
		N	113	113	115	114	113	108	113	115	109	107	114	114	106	106	113	110	109	111	110	98
	Q5_Q6	Correlation Coefficient	,342**	,028	,147	1,000	,143	,107	,282**	,118	,040	-,036	,059	,408**	,428**	,173	-,091	,198*	,234*	,062	-,062	,162
		Sig. (2-tailed)	,000	,771	,120	.	,131	,270	,003	,213	,680	,711	,531	,000	,000	,076	,338	,038	,015	,515	,523	,112
		N	113	112	114	114	113	108	112	114	109	107	114	114	106	106	113	110	109	111	110	98
	Q7_Q8	Correlation Coefficient	,183	-,105	-,286**	,143	1,000	-,160	-,278**	,057	,452**	,254**	,184	,203*	,126	,127	,302**	,379**	,353**	-,241*	-,038	,218*
		Sig. (2-tailed)	,054	,272	,002	,131	.	,099	,003	,549	,000	,008	,051	,031	,202	,194	,001	,000	,000	,011	,694	,031
		N	112	111	113	113	113	107	111	113	108	107	113	113	105	106	112	110	109	111	110	98
	q9_PYSOC	Correlation Coefficient	,137	,486**	,420**	,107	-,160	1,000	,260**	,031	-,317**	-,005	-,180	-,023	,097	-,021	-,041	,013	-,014	,309**	-,045	,215*
		Sig. (2-tailed)	,160	,000	,000	,270	,099	.	,007	,746	,001	,962	,062	,812	,332	,831	,676	,897	,886	,001	,647	,038
		N	107	107	108	108	107	108	107	108	105	103	108	108	102	103	107	105	104	106	104	93
	Q10_Q13	Correlation Coefficient	,294**	,121	,146	,282**	-,278**	,260**	1,000	,419**	-,275**	,053	-,002	,176	,239*	,054	-,191*	-,014	,141	,195*	-,076	,140
		Sig. (2-tailed)	,002	,204	,123	,003	,003	,007	.	,000	,004	,586	,981	,064	,014	,586	,044	,887	,145	,042	,433	,169
		N	111	112	113	112	111	107	113	113	109	106	112	112	105	105	111	109	108	110	108	98
	Q11_Q12	Correlation Coefficient	,073	-,019	,010	,118	,057	,031	,419**	1,000	-,013	,009	,107	,240*	,214*	,049	,122	,178	,173	,082	-,136	,011
		Sig. (2-tailed)	,441	,843	,914	,213	,549	,746	,000	.	,895	,927	,258	,010	,027	,618	,197	,063	,073	,390	,156	,913
		N	113	113	115	114	113	108	113	115	109	107	114	114	106	106	113	110	109	111	110	98
	q14_PYSIC	Correlation Coefficient	,052	-,260**	-,326**	,040	,452**	-,317**	-,275**	-,013	1,000	,068	,189*	,134	-,078	,169	,226*	,100	,076	-,296**	,080	,077
		Sig. (2-tailed)	,594	,007	,001	,680	,000	,001	,004	,895	.	,493	,049	,164	,432	,089	,019	,304	,439	,002	,415	,459
		N	108	108	109	109	108	105	109	109	109	105	109	109	103	103	108	107	105	107	105	96
	q16_PYSOC	Correlation Coefficient	,069	,032	-,109	-,036	,254**	-,005	,053	,009	,068	1,000	,223*	,226*	-,036	,166	,041	,165	,189	-,011	,219*	,067
		Sig. (2-tailed)	,484	,744	,266	,711	,008	,962	,586	,927	,493	.	,021	,019	,721	,094	,680	,091	,055	,911	,025	,522
		N	106	105	107	107	107	103	106	107	105	107	107	107	100	103	106	106	104	105	105	94
	q17_PYSOC	Correlation Coefficient	,038	-,075	-,158	,059	,184	-,180	-,002	,107	,189*	,223*	1,000	,410**	-,103	,154	,350**	,484**	,225*	-,240*	,036	,124
		Sig. (2-tailed)	,690	,429	,094	,531	,051	,062	,981	,258	,049	,021	.	,000	,295	,116	,000	,000	,019	,011	,711	,224
		N	113	112	114	114	113	108	112	114	109	107	114	114	106	106	113	110	109	111	110	98
	Q18_Q19	Correlation Coefficient	,243**	,016	-,085	,408**	,203*	-,023	,176	,240*	,134	,226*	,410**	1,000	,411**	,277**	,160	,428**	,376**	,028	,018	,214*
		Sig. (2-tailed)	,009	,866	,371	,000	,031	,812	,064	,010	,164	,019	,000	.	,000	,004	,090	,000	,000	,769	,854	,034
		N	113	112	114	114	113	108	112	114	109	107	114	114	106	106	113	110	109	111	110	98
	Q20_Q21	Correlation Coefficient	,228*	,053	,193*	,428**	,126	,097	,239*	,214*	-,078	-,036	-,103	,411**	1,000	,091	-,001	,203*	,369**	,119	-,110	,272**
		Sig. (2-tailed)	,019	,589	,047	,000	,202	,332	,014	,027	,432	,721	,295	,000	.	,360	,995	,038	,000	,227	,273	,007
		N	105	105	106	106	105	102	105	106	103	100	106	106	106	102	105	104	103	104	102	96
	q22_PYSOC	Correlation Coefficient	-,092	,047	,030	,173	,127	-,021	,054	,049	,169	,166	,154	,277**	,091	1,000	-,051	,117	,036	,022	,021	,095
		Sig. (2-tailed)	,351	,635	,759	,076	,194	,831	,586	,618	,089	,094	,116	,004	,360	.	,607	,238	,715	,825	,834	,359
		N	105	105	106	106	106	103	105	106	103	103	106	106	102	106	105	104	104	105	105	95
	Q23_Q24_Q25	Correlation Coefficient	-,075	-,086	-,156	-,091	,302**	-,041	-,191*	,122	,226*	,041	,350**	,160	-,001	-,051	1,000	,440**	,211*	-,285**	,008	,113
		Sig. (2-tailed)	,431	,371	,099	,338	,001	,676	,044	,197	,019	,680	,000	,090	,995	,607	.	,000	,028	,003	,937	,270
		N	112	111	113	113	112	107	111	113	108	106	113	113	105	105	113	109	108	110	109	98
	Q26_Q27	Correlation Coefficient	,055	,054	-,016	,198*	,379**	,013	-,014	,178	,100	,165	,484**	,428**	,203*	,117	,440**	1,000	,574**	-,227*	-,068	,311**
		Sig. (2-tailed)	,571	,579	,869	,038	,000	,897	,887	,063	,304	,091	,000	,000	,038	,238	,000	.	,000	,018	,484	,002
		N	109	108	110	110	110	105	109	110	107	106	110	110	104	104	109	110	107	108	107	97
	Q28_Q29	Correlation Coefficient	,125	-,103	-,035	,234*	,353**	-,014	,141	,173	,076	,189	,225*	,376**	,369**	,036	,211*	,574**	1,000	-,176	-,088	,373**
		Sig. (2-tailed)	,196	,285	,716	,015	,000	,886	,145	,073	,439	,055	,019	,000	,000	,715	,028	,000	.	,067	,366	,000
		N	108	109	109	109	109	104	108	109	105	104	109	109	103	104	108	107	109	109	107	97
	q30_PYSOC	Correlation Coefficient	-,006	,222*	,398**	,062	-,241*	,309**	,195*	,082	-,296**	-,011	-,240*	,028	,119	,022	-,285**	-,227*	-,176	1,000	,203*	,060
		Sig. (2-tailed)	,947	,019	,000	,515	,011	,001	,042	,390	,002	,911	,011	,769	,227	,825	,003	,018	,067	.	,035	,561
		N	110	111	111	111	111	106	110	111	107	105	111	111	104	105	110	108	109	111	108	97
	q31_PYSOC	Correlation Coefficient	,010	-,003	,042	-,062	-,038	-,045	-,076	-,136	,080	,219*	,036	,018	-,110	,021	,008	-,068	-,088	,203*	1,000	,027
		Sig. (2-tailed)	,914	,972	,663	,523	,694	,647	,433	,156	,415	,025	,711	,854	,273	,834	,937	,484	,366	,035	.	,796
		N	109	108	110	110	110	104	108	110	105	105	110	110	102	105	109	107	107	108	110	96
	q36_PYSOC	Correlation Coefficient	,079	,271**	,053	,162	,218*	,215*	,140	,011	,077	,067	,124	,214*	,272**	,095	,113	,311**	,373**	,060	,027	1,000
		Sig. (2-tailed)	,444	,007	,604	,112	,031	,038	,169	,913	,459	,522	,224	,034	,007	,359	,270	,002	,000	,561	,796	.
		N	97	97	98	98	98	93	98	98	96	94	98	98	96	95	98	97	97	97	96	98

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

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10.6.5 Control of statistically significant differences between job satisfaction and performance monitoring (call centres)

Case Summaries

Job satisfaction

q32_PYSOC	N	Mean	Median	Minimum	Maximum	Std. Deviation
1	55	2,7909	3,0000	1,00	4,50	1,09160
2	54	2,6111	2,5000	1,00	4,50	,96967
Total	109	2,7018	2,5000	1,00	4,50	1,03217

Test Statistics[a]

	Job satisfaction
Mann-Whitney U	1319,500
Wilcoxon W	2804,500
Z	-1,016
Asymp. Sig. (2-tailed)	,310

a. Grouping Variable: q32_PYSOC: Information for the performance cotrol

Case Summaries

Job satisfaction

q33_PYSOC	N	Mean	Median	Minimum	Maximum	Std. Deviation
1	3	3,0000	4,0000	1,00	4,00	1,73205
2	106	2,7075	2,7500	1,00	4,50	1,02555
Total	109	2,7156	3,0000	1,00	4,50	1,03942

Test Statistics[a]

	Job satisfaction
Mann-Whitney U	128,500
Wilcoxon W	5799,500
Z	-,572
Asymp. Sig. (2-tailed)	,567
Exact Sig. [2*(1-tailed Sig.)]	,591[b]

a. Grouping Variable: q33_PYSOC: Consultation during the performance control

b. Not corrected for ties.

Case Summaries

Job satisfaction

q34_PYSOC	N	Mean	Median	Minimum	Maximum	Std. Deviation
1	7	3,5714	4,0000	2,00	4,00	,78680
2	94	2,6596	2,5000	1,00	4,50	1,00057
Total	101	2,7228	3,0000	1,00	4,50	1,01113

Test Statistics[a]

	Job satisfaction
Mann-Whitney U	159,000
Wilcoxon W	4624,000
Z	-2,303
Asymp. Sig. (2-tailed)	,021

a. Grouping Variable: q34_PYSOC: Comments taken into account

Case Summaries

Job satisfaction

q35_PYSOC	N	Mean	Median	Minimum	Maximum	Std. Deviation
1	66	2,8409	3,0000	1,00	4,50	1,10648
2	36	2,5278	2,5000	1,00	4,00	,93308
Total	102	2,7304	3,0000	1,00	4,50	1,05463

Test Statistics[a]

	Job satisfaction
Mann-Whitney U	983,500
Wilcoxon W	1649,500
Z	-1,450
Asymp. Sig. (2-tailed)	,147

a. Grouping Variable: q35_PYSOC: Are your immediate superiors trained to judge your performance on a predescribed way, fair and confidentially?

10.6.6 Regression tables for the Psychosocial Questionnaire (Call centres)

10.6.6.1 Regression tables for job stress (Call centres)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,573[a]	,328	,221	1,171

a. Predictors: (Constant), q17_PYSOC, q31_PYSOC, Q11_Q12, q9_PYSOC, Q28_Q29, q14_PYSIC, q30_PYSOC, q13_PYSOC, Q23_Q24_Q25, q15_PYSOC, Q1_Q2, Q3_Q4, Q26_Q27
b. Dependent Variable: q45_PYSOC

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	54,891	13	4,222	3,079	,001[a]
	Residual	112,443	82	1,371		
	Total	167,333	95			

a. Predictors: (Constant), q17_PYSOC, q31_PYSOC, Q11_Q12, q9_PYSOC, Q28_Q29, q14_PYSIC, q30_PYSOC, q13_PYSOC, Q23_Q24_Q25, q15_PYSOC, Q1_Q2, Q3_Q4, Q26_Q27
b. Dependent Variable: q45_PYSOC

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95,0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	1,940	1,393		1,393	,167	-,831	4,711		
	Q1_Q2	,230	,147	,177	1,561	,122	-,063	,523	,639	1,565
	Q3_Q4	,305	,167	,209	1,828	,071	-,027	,636	,625	1,601
	Q11_Q12	-,318	,142	-,232	-2,246	,027	-,600	-,036	,766	1,306
	Q23_Q24_Q25	-,132	,251	-,060	-,526	,600	-,632	,368	,637	1,569
	Q26_Q27	-,062	,214	-,039	-,289	,773	-,487	,363	,455	2,196
	Q28_Q29	-,031	,165	-,021	-,187	,852	-,358	,297	,633	1,579
	q9_PYSOC	,058	,120	,058	,478	,634	-,182	,297	,564	1,774
	q15_PYSOC	,146	,125	,131	1,166	,247	-,103	,395	,646	1,549
	q30_PYSOC	,005	,134	,004	,037	,971	-,261	,271	,607	1,646
	q31_PYSOC	,236	,139	,166	1,701	,093	-,040	,512	,859	1,164
	q13_PYSOC	-,119	,152	-,081	-,785	,434	-,421	,182	,763	1,310
	q14_PYSIC	-,146	,101	-,148	-1,435	,155	-,347	,056	,773	1,294
	q17_PYSOC	,107	,195	,061	,547	,586	-,281	,495	,653	1,532

a. Dependent Variable: q45_PYSOC

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	1,07	5,33	2,67	,760	96
Residual	-1,910	2,470	,000	1,088	96
Std. Predicted Value	-2,102	3,502	,000	1,000	96
Std. Residual	-1,631	2,109	,000	,929	96

a. Dependent Variable: q45_PYSOC

Model Summary[e]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,354[a]	,125	,116	1,248
2	,443[b]	,197	,179	1,202
3	,490[c]	,240	,215	1,176
4	,522[d]	,272	,240	1,157

a. Predictors: (Constant), Q3_Q4
b. Predictors: (Constant), Q3_Q4, Q11_Q12
c. Predictors: (Constant), Q3_Q4, Q11_Q12, q15_PYSOC
d. Predictors: (Constant), Q3_Q4, Q11_Q12, q15_PYSOC, Q1_Q2
e. Dependent Variable: q45_PYSOC

ANOVA[e]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	20,937	1	20,937	13,443	,000[a]
	Residual	146,397	94	1,557		
	Total	167,333	95			
2	Regression	32,913	2	16,456	11,385	,000[b]
	Residual	134,421	93	1,445		
	Total	167,333	95			
3	Regression	40,125	3	13,375	9,673	,000[c]
	Residual	127,208	92	1,383		
	Total	167,333	95			
4	Regression	45,551	4	11,388	8,509	,000[d]
	Residual	121,782	91	1,338		
	Total	167,333	95			

a. Predictors: (Constant), Q3_Q4

b. Predictors: (Constant), Q3_Q4, Q11_Q12

c. Predictors: (Constant), Q3_Q4, Q11_Q12, q15_PYSOC

d. Predictors: (Constant), Q3_Q4, Q11_Q12, q15_PYSOC, Q1_Q2

ANOVA[e]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	20,937	1	20,937	13,443	,000[a]
	Residual	146,397	94	1,557		
	Total	167,333	95			
2	Regression	32,913	2	16,456	11,385	,000[b]
	Residual	134,421	93	1,445		
	Total	167,333	95			
3	Regression	40,125	3	13,375	9,673	,000[c]
	Residual	127,208	92	1,383		
	Total	167,333	95			
4	Regression	45,551	4	11,388	8,509	,000[d]
	Residual	121,782	91	1,338		
	Total	167,333	95			

a. Predictors: (Constant), Q3_Q4

b. Predictors: (Constant), Q3_Q4, Q11_Q12

c. Predictors: (Constant), Q3_Q4, Q11_Q12, q15_PYSOC

d. Predictors: (Constant), Q3_Q4, Q11_Q12, q15_PYSOC, Q1_Q2

e. Dependent Variable: q45_PYSOC

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	1,675	,299		5,599	,000	1,081	2,268		
	Q3_Q4	,515	,140	,354	3,667	,000	,236	,794	1,000	1,000
2	(Constant)	2,785	,481		5,784	,000	1,829	3,741		
	Q3_Q4	,531	,135	,365	3,924	,000	,262	,800	,998	1,002
	Q11_Q12	-,367	,127	-,268	-2,878	,005	-,620	-,114	,998	1,002
3	(Constant)	2,467	,491		5,025	,000	1,492	3,442		
	Q3_Q4	,438	,139	,301	3,156	,002	,162	,713	,911	1,098
	Q11_Q12	-,408	,126	-,298	-3,238	,002	-,658	-,158	,978	1,022
	q15_PYSOC	,244	,107	,220	2,284	,025	,032	,456	,892	1,121
4	(Constant)	2,002	,535		3,740	,000	,939	3,066		
	(Q3-Q4) : Learning demands	,339	,145	,233	2,342	,021	,052	,627	,807	1,239
	Q11_Q12: Control of work pacing	-,405	,124	-,296	-3,269	,002	-,651	-,159	,978	1,023
	Q15_Rumors for work	,230	,105	,207	2,185	,031	,021	,440	,888	1,126
	(Q1-Q2) : Quantitative demands	,253	,125	,194	2,014	,047	,003	,502	,862	1,160

a. Dependent Variable: q45_PYSOC

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	1,03	4,71	2,70	,701	104
Residual	-2,150	2,485	-,015	1,146	104
Std. Predicted Value	-2,363	2,953	,045	1,013	104
Std. Residual	-1,859	2,148	-,013	,990	104

a. Dependent Variable: q45_PYSOC

10.6.6.2 Regression tables for job satisfaction (Call centres)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,442[a]	,195	,150	,92964

a. Predictors: (Constant), q34_PYSOC, Q18_Q19, Q10_Q13, Q5_Q6, Q20_Q21
b. Dependent Variable: Job satisfaction

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	18,673	5	3,735	4,321	,001[a]
	Residual	76,916	89	,864		
	Total	95,589	94			

a. Predictors: (Constant), q34_PYSOC, Q18_Q19, Q10_Q13, Q5_Q6, Q20_Q21
b. Dependent Variable: Job satisfaction

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	2,546	1,089		2,338	,022	,382	4,709		
	Q5_Q6	,182	,104	,203	1,752	,083	-,024	,389	,672	1,488
	Q10_Q13	,204	,111	,191	1,849	,068	-,015	,424	,848	1,180
	Q18_Q19	,079	,121	,072	,652	,516	-,161	,318	,732	1,366
	Q20_Q21	,039	,107	,042	,361	,719	-,175	,252	,659	1,517
	q34_PYSOC	-,583	,455	-,130	-1,281	,203	-1,488	,321	,880	1,136

a. Dependent Variable: Job satisfaction

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	1,9612	4,3796	2,6895	,44570	95
Residual	-1,85731	2,16023	,00000	,90458	95
Std. Predicted Value	-1,634	3,792	,000	1,000	95
Std. Residual	-1,998	2,324	,000	,973	95

a. Dependent Variable: Job satisfaction

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,353[a]	,125	,116	,94840
2	,413[b]	,171	**,153**	,92810

a. Predictors: (Constant), Q5_Q6
b. Predictors: (Constant), Q5_Q6, Q10_Q13
c. Dependent Variable: Job satisfaction

ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11,940	1	11,940	13,275	,000[a]
	Residual	83,649	93	,899		
	Total	95,589	94			
2	Regression	16,344	2	8,172	9,487	,000[b]
	Residual	79,245	92	,861		
	Total	95,589	94			

a. Predictors: (Constant), Positive challenges

b. Predictors: (Constant), Positive challenges, Control of work pacing

c. Dependent Variable: Job satisfaction

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95,0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	1,825	,256		7,122	,000	1,316	2,334		
	Q5_Q6	,317	,087	,353	3,643	,000	,144	,490	1,000	1,000
2	(Constant)	1,515	,286		5,295	,000	,946	2,083		
	Positive challenges: (Q5_Q6)	,251	,090	,280	2,789	,006	,072	,430	,895	1,117
	Control of decisions: (Q10_Q13)	,243	,107	,227	2,261	,026	,030	,456	,895	1,117

a. Dependent Variable: Job satisfaction

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	2,0083	3,8620	2,6843	,40145	111
Residual	-2,00804	2,24074	,04996	,92403	111
Std. Predicted Value	-1,634	2,812	-,012	,963	111
Std. Residual	-2,164	2,414	,054	,996	111

a. Dependent Variable: Job satisfaction

10.6.7 Control for statistically significant differences between the MSD and Psychosocial Questionnaire (Call centres)

10.6.7.1 Control for statistically significant differences between job stress and MSD symptoms (Call centres)

q45_Job stress

qm14_MSD (12 months neck)	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	19	3,11	3,00	1,487	1	5
2	17	3,35	4,00	1,272	1	5
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	Job stress
Mann-Whitney U	146,500
Wilcoxon W	336,500
Z	-,486
Asymp. Sig. (2-tailed)	,627
Exact Sig. [2*(1-tailed Sig.)]	,639[b]

a. Grouping Variable: qm14_MSD

b. Not corrected for ties.

q45_Job stress

qm15_MSD (12 months neck prevented from work)	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	29	3,10	3,00	1,448	1	5
2	7	3,71	4,00	,951	2	5
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_PYSOC
Mann-Whitney U	77,500
Wilcoxon W	512,500
Z	-,981
Asymp. Sig. (2-tailed)	,327
Exact Sig. [2*(1-tailed Sig.)]	,345[b]

a. Grouping Variable: qm15_MSD

b. Not corrected for ties.

Case Summaries

q45_PYSOC

qm16_MSD (neck last 7 days)	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	29	2,93	3,00	1,361	1	5
2	7	4,43	4,00	,535	4	5
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	37,500
Wilcoxon W	472,500
Z	-2,615
Asymp. Sig. (2-tailed)	,009
Exact Sig. [2*(1-tailed Sig.)]	,008[b]

a. Grouping Variable: qm16_MSD

b. Not corrected for ties.

q45_Job stress

MSDqm14_15_16	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	19	3,11	3,00	1,487	1	5
2	17	3,35	4,00	1,272	1	5
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	146,500
Wilcoxon W	336,500
Z	-,486
Asymp. Sig. (2-tailed)	,627
Exact Sig. [2*(1-tailed Sig.)]	,639[b]

a. Grouping Variable: MSDqm14_15_16

b. Not corrected for ties.

Case Summaries

q45_Job stress

qmNEW17_MSD (Symptoms 12 months shoulders, any symp-tom)	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	25	2,88	3,00	1,424	1	5
2	11	4,00	4,00	,894	3	5
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	75,000
Wilcoxon W	400,000
Z	-2,194
Asymp. Sig. (2-tailed)	,028
Exact Sig. [2*(1-tailed Sig.)]	,032[b]

a. Grouping Variable: qmNEW17_MSD b. Not corrected for ties.

Case Summaries

q45_Job stress

qm18_MSD (Shoulders 12 months pre-vented from work)	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	30	3,10	3,00	1,423	1	5
2	6	3,83	3,50	,983	3	5
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	64,000
Wilcoxon W	529,000
Z	-1,128
Asymp. Sig. (2-tailed)	,259
Exact Sig. [2*(1-tailed Sig.)]	,287[b]

a. Grouping Variable: qm18_MSD

b. Not corrected for ties.

Case Summaries

q45_Job stress

qm19_MSD (Shoulders 7 days)	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	30	3,00	3,00	1,365	1	5
2	6	4,33	4,50	,816	3	5
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	39,500
Wilcoxon W	504,500
Z	-2,192
Asymp. Sig. (2-tailed)	,028
Exact Sig. [2*(1-tailed Sig.)]	,029[b]

a. Grouping Variable: qm19_MSD

b. Not corrected for ties.

Case Summaries

q45_Job stress

MSDqm17_18_19	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	25	2,88	3,00	1,424	1	5
2	11	4,00	4,00	,894	3	5
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	75,000
Wilcoxon W	400,000
Z	-2,194
Asymp. Sig. (2-tailed)	,028
Exact Sig. [2*(1-tailed Sig.)]	,032[b]

a. Grouping Variable: MSDqm17_18_19

b. Not corrected for ties.

Case Summaries

q45_Job stress

qmNEW20_MSD (Symptoms 12 months elbows, any symptom)	N	Mean	Median	Std. Deviation	Minimum	Maximum
1,00	34	3,21	3,00	1,409	1	5
2,00	2	3,50	3,50	,707	3	4
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	31,000
Wilcoxon W	626,000
Z	-,212
Asymp. Sig. (2-tailed)	,832
Exact Sig. [2*(1-tailed Sig.)]	,863[b]

a. Grouping Variable: qmNEW20_MSD

b. Not corrected for ties.

Case Summaries

q45_Job stress

qm21_MSD (Symptoms 12 months elbows, prevented from work)	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	35	3,20	3,00	1,389	1	5
2	1	4,00	4,00	.	4	4
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	12,000
Wilcoxon W	642,000
Z	-,541
Asymp. Sig. (2-tailed)	,588
Exact Sig. [2*(1-tailed Sig.)]	,722[b]

a. Grouping Variable: qm21_MSD

b. Not corrected for ties.

Case Summaries

q45_PYSOC

qm22_MSD	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	34	3,21	3,00	1,409	1	5
2	2	3,50	3,50	,707	3	4
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_PYSOC
Mann-Whitney U	31,000
Wilcoxon W	626,000
Z	-,212
Asymp. Sig. (2-tailed)	,832
Exact Sig. [2*(1-tailed Sig.)]	,863[b]

a. Grouping Variable: qm22_MSD

b. Not corrected for ties.

Case Summaries

q45_Job stress

MSDqm20_21_22	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	34	3,21	3,00	1,409	1	5
2	2	3,50	3,50	,707	3	4
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	31,000
Wilcoxon W	626,000
Z	-,212
Asymp. Sig. (2-tailed)	,832
Exact Sig. [2*(1-tailed Sig.)]	,863[b]

a. Grouping Variable: MSDqm20_21_22

b. Not corrected for ties.

Case Summaries

q45_Job stress

qmNEW23_MSD (Symptoms 12 months wrists/hands, any symptom)	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	25	3,36	4,00	1,497	1	5
2	11	2,91	3,00	1,044	1	4
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	108,000
Wilcoxon W	174,000
Z	-1,036
Asymp. Sig. (2-tailed)	,300
Exact Sig. [2*(1-tailed Sig.)]	,324[b]

a. Grouping Variable: qmNEW23_MSD

b. Not corrected for ties.

Case Summaries

q45_Job stress

qm24_MSD (Symptoms 12 months wrists/hands, prevented work)	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	31	3,32	4,00	1,423	1	5
2	5	2,60	2,00	,894	2	4
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_PYSOC
Mann-Whitney U	52,000
Wilcoxon W	67,000
Z	-1,193
Asymp. Sig. (2-tailed)	,233
Exact Sig. [2*(1-tailed Sig.)]	,262[b]

a. Grouping Variable: qm24_MSD

b. Not corrected for ties.

Case Summaries

q45_Job stress

qm25_MSD (Symptoms wrists/hands 7 days)	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	31	3,26	3,00	1,437	1	5
2	5	3,00	3,00	1,000	2	4
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	Job stress
Mann-Whitney U	67,000
Wilcoxon W	82,000
Z	-,491
Asymp. Sig. (2-tailed)	,623
Exact Sig. [2*(1-tailed Sig.)]	,657[b]

a. Grouping Variable: qm25_MSD
b. Not corrected for ties.

Case Summaries

q45_Job stress

MSDqm23_24_25	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	25	3,36	4,00	1,497	1	5
2	11	2,91	3,00	1,044	1	4
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	108,000
Wilcoxon W	174,000
Z	-1,036
Asymp. Sig. (2-tailed)	,300
Exact Sig. [2*(1-tailed Sig.)]	,324[b]

a. Grouping Variable: MSDqm23_24_25

b. Not corrected for ties.

Case Summaries

q45_Job stress

qm26_MSD (Symptoms 12 months upper back)	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	28	3,21	3,50	1,343	1	5
2	8	3,25	3,00	1,581	1	5
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	109,500
Wilcoxon W	515,500
Z	-,097
Asymp. Sig. (2-tailed)	,923
Exact Sig. [2*(1-tailed Sig.)]	,926[b]

a. Grouping Variable: qm26_MSD

b. Not corrected for ties.

Case Summaries

q45_Job stress

qm27_MSD (Symptoms 12 months upper back, prevent-ed work)	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	34	3,18	3,00	1,381	1	5
2	2	4,00	4,00	1,414	3	5
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	22,500
Wilcoxon W	617,500
Z	-,812
Asymp. Sig. (2-tailed)	,417
Exact Sig. [2*(1-tailed Sig.)]	,457[b]

a. Grouping Variable: qm27_MSD

b. Not corrected for ties.

Case Summaries

q45_Job stress

qm28_MSD (Symptoms up-per back 7 days)	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	34	3,18	3,00	1,381	1	5
2	2	4,00	4,00	1,414	3	5
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	22,500
Wilcoxon W	617,500
Z	-,812
Asymp. Sig. (2-tailed)	,417
Exact Sig. [2*(1-tailed Sig.)]	,457[b]

a. Grouping Variable: qm28_MSD

b. Not corrected for ties.

Case Summaries

q45_Job stress

MSDqm26_27_28	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	28	3,21	3,50	1,343	1	5
2	8	3,25	3,00	1,581	1	5
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	109,500
Wilcoxon W	515,500
Z	-,097
Asymp. Sig. (2-tailed)	,923
Exact Sig. [2*(1-tailed Sig.)]	,926[b]

a. Grouping Variable: MSDqm26_27_28 b. Not corrected for ties.

Case Summaries

q45_PYSOC

qm29_MSD (Symptoms 12 months lower back)	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	23	3,26	4,00	1,453	1	5
2	13	3,15	3,00	1,281	1	5
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	141,000
Wilcoxon W	232,000
Z	-,286
Asymp. Sig. (2-tailed)	,775
Exact Sig. [2*(1-tailed Sig.)]	,795[b]

a. Grouping Variable: qm29_MSD

b. Not corrected for ties.

Case Summaries

q45_Job stress

qm30_MSD (Symptoms 12 months upper back prevented work)	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	30	3,20	3,00	1,472	1	5
2	6	3,33	3,50	,816	2	4
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	88,000
Wilcoxon W	553,000
Z	-,087
Asymp. Sig. (2-tailed)	,931
Exact Sig. [2*(1-tailed Sig.)]	,951[b]

a. Grouping Variable: qm30_MSD

b. Not corrected for ties.

Case Summaries

q45_Job stress

qm31_MSD (Symptoms upper back 7 days)	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	27	3,22	3,00	1,450	1	5
2	9	3,22	3,00	1,202	1	5
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	119,500
Wilcoxon W	164,500
Z	-,075
Asymp. Sig. (2-tailed)	,940
Exact Sig. [2*(1-tailed Sig.)]	,943[b]

a. Grouping Variable: qm31_MSD, b. Not corrected for ties.

Case Summaries

q45_Job stress

MSDqm29_30_31	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	23	3,26	4,00	1,453	1	5
2	13	3,15	3,00	1,281	1	5
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	141,000
Wilcoxon W	232,000
Z	-,286
Asymp. Sig. (2-tailed)	,775
Exact Sig. [2*(1-tailed Sig.)]	,795[b]

a. Grouping Variable: MSDqm29_30_31

b. Not corrected for ties.

Case Summaries

q45_Job stress

qm32_MSD (Symptoms 12 months hips)	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	30	3,10	3,00	1,423	1	5
2	6	3,83	3,50	,983	3	5
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	64,000
Wilcoxon W	529,000
Z	-1,128
Asymp. Sig. (2-tailed)	,259
Exact Sig. [2*(1-tailed Sig.)]	,287[b]

a. Grouping Variable: qm32_MSD b. Not corrected for ties.

Case Summaries

q45_Job stress

qm33_MSD (Symptoms 12 months hips prevented work)	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	34	3,21	3,00	1,409	1	5
2	2	3,50	3,50	,707	3	4
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	31,000
Wilcoxon W	626,000
Z	-,212
Asymp. Sig. (2-tailed)	,832
Exact Sig. [2*(1-tailed Sig.)]	,863[b]

a. Grouping Variable: qm33_MSD

b. Not corrected for ties.

Case Summaries

q45_Job stress

qm34_MSD (Symptoms hips 7 days)	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	32	3,22	3,00	1,362	1	5
2	4	3,25	3,50	1,708	1	5
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	62,500
Wilcoxon W	590,500
Z	-,077
Asymp. Sig. (2-tailed)	,938
Exact Sig. [2*(1-tailed Sig.)]	,942[b]

a. Grouping Variable: qm34_MSD

b. Not corrected for ties.

Case Summaries

q45_Job stress

MSDqm32_33_34	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	30	3,10	3,00	1,423	1	5
2	6	3,83	3,50	,983	3	5
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	64,000
Wilcoxon W	529,000
Z	-1,128
Asymp. Sig. (2-tailed)	,259
Exact Sig. [2*(1-tailed Sig.)]	,287[b]

a. Grouping Variable: MSDqm32_33_34

b. Not corrected for ties.

Case Summaries

q45_Job stress

qm35_MSD (Symptoms 12 months knees)	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	29	3,21	3,00	1,346	1	5
2	7	3,29	4,00	1,604	1	5
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	97,000
Wilcoxon W	532,000
Z	-,184
Asymp. Sig. (2-tailed)	,854
Exact Sig. [2*(1-tailed Sig.)]	,876[b]

a. Grouping Variable: qm35_MSD

b. Not corrected for ties.

Case Summaries

q45_Job stress

qm36_MSD (Symptoms 12 months knees, prevented work)	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	33	3,27	3,00	1,398	1	5
2	3	2,67	2,00	1,155	2	4
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	36,000
Wilcoxon W	42,000
Z	-,790
Asymp. Sig. (2-tailed)	,430
Exact Sig. [2*(1-tailed Sig.)]	,476[b]

a. Grouping Variable: qm36_MSD b. Not corrected for ties.

Case Summaries

q45_Job stress

qm37_MSD (Symptoms knees 7 days)	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	34	3,18	3,00	1,381	1	5
2	2	4,00	4,00	1,414	3	5
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	22,500
Wilcoxon W	617,500
Z	-,812
Asymp. Sig. (2-tailed)	,417
Exact Sig. [2*(1-tailed Sig.)]	,457[b]

a. Grouping Variable: qm37_MSD

b. Not corrected for ties.

Case Summaries

q45_Job stress

MSDqm35_36_37	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	29	3,21	3,00	1,346	1	5
2	7	3,29	4,00	1,604	1	5
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_PYSOC
Mann-Whitney U	97,000
Wilcoxon W	532,000
Z	-,184
Asymp. Sig. (2-tailed)	,854
Exact Sig. [2*(1-tailed Sig.)]	,876[b]

a. Grouping Variable: MSDqm35_36_37 b. Not corrected for ties.

Case summaries

q45_Job stress

qm38_MSD (Symptoms 12 months ankles/feet)	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	31	3,29	3,00	1,395	1	5
2	5	2,80	3,00	1,304	1	4
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	61,000
Wilcoxon W	76,000
Z	-,772
Asymp. Sig. (2-tailed)	,440
Exact Sig. [2*(1-tailed Sig.)]	,476[b]

a. Grouping Variable: qm38_MSD b. Not corrected for ties.

Case Summaries

q45_Job stress

qm39_MSD (Symptoms 12 months ankles/feet, prevented work)	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	35	3,26	3,00	1,379	1	5
2	1	2,00	2,00	.	2	2
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	8,000
Wilcoxon W	9,000
Z	-,935
Asymp. Sig. (2-tailed)	,350
Exact Sig. [2*(1-tailed Sig.)]	,500[b]

a. Grouping Variable: qm39_MSD

b. Not corrected for ties.

Case Summaries

q45_Job stress

qm40_MSD (Symptoms ankles / feet 7 days)	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	34	3,21	3,00	1,409	1	5
2	2	3,50	3,50	,707	3	4
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	31,000
Wilcoxon W	626,000
Z	-,212
Asymp. Sig. (2-tailed)	,832
Exact Sig. [2*(1-tailed Sig.)]	,863[b]

a. Grouping Variable: qm40_MSD

b. Not corrected for ties.

Case Summaries

q45_Job stress

MSDqm38_39_40	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	31	3,29	3,00	1,395	1	5
2	5	2,80	3,00	1,304	1	4
Total	36	3,22	3,00	1,376	1	5

Test Statistics[a]

	q45_PYSOC
Mann-Whitney U	61,000
Wilcoxon W	76,000
Z	-,772
Asymp. Sig. (2-tailed)	,440
Exact Sig. [2*(1-tailed Sig.)]	,476[b]

a. Grouping Variable: MSDqm38_39_40

b. Not corrected for ties.

10.6.7.2 Control for statistically significant differences between control of work pacing and MSD symptoms (Call centres)

Control of work pacing

qm16_MSD	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	29	3,2069	3,5000	,99568	1,00	5,00
2	8	2,4375	2,5000	,72887	1,50	3,50
Total	37	3,0405	3,0000	,98867	1,00	5,00

Ranks

	qm16_MSD	N	Mean Rank	Sum of Ranks
Control of work pacing	1	29	20,95	607,50
	2	8	11,94	95,50
	Total	37		

Qm16MSD: Symptoms in the neck the last 7 days

Test Statistics[a]

	Control of work pacing
Mann-Whitney U	59,500
Wilcoxon W	95,500
Z	-2,109
Asymp. Sig. (2-tailed)	,035
Exact Sig. [2*(1-tailed Sig.)]	,035[b]

a. Grouping Variable: qm16_MSD
b. Not corrected for ties.

****

10.6.7.3 Control for statistically significant differences between quantitative demands and MSD symptoms (Call centres)

Case Summaries

Quantitative demands

qm27_MSD	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	35	2,8571	2,5000	,99684	1,00	5,00
2	2	4,7500	4,7500	,35355	4,50	5,00
Total	37	2,9595	2,5000	1,06313	1,00	5,00

Ranks

	qm27_MSD	N	Mean Rank	Sum of Ranks
Quantitative demands	1	35	18,10	633,50
	2	2	34,75	69,50
	Total	37		

Test Statistics[a]

	Quantitative demands
Mann-Whitney U	3,500
Wilcoxon W	633,500
Z	-2,147
Asymp. Sig. (2-tailed)	**,032**
Exact Sig. [2*(1-tailed Sig.)]	,018[b]

a. Grouping Variable: qm27_MSD: Symptoms in the upper back the last 12 months, prevented from work
b. Not corrected for ties.

*****

Case Summaries

Quantitative demands

qm29_MSD	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	25	2,7400	2,5000	1,06184	1,00	5,00
2	12	3,4167	3,5000	,94948	1,50	5,00
Total	37	2,9595	2,5000	1,06313	1,00	5,00

Ranks

	qm29_MSD	N	Mean Rank	Sum of Ranks
Quantitative demands	1	25	16,54	413,50
	2	12	24,13	289,50
	Total	37		

Test Statistics[a]

	Q1_Q2
Mann-Whitney U	88,500
Wilcoxon W	413,500
Z	-2,025
Asymp. Sig. (2-tailed)	**,043**
Exact Sig. [2*(1-tailed Sig.)]	,045b

a. Grouping Variable: qm29_MSD: Symptoms the last 12 months at the lower back
b. Not corrected for ties.

10.6.7.4 Control for statistically significant differences between performance monitoring and MSD symptoms (Call centres)

Q33: Consultation during performance monitoring

Crosstab

			qmNEW17_MSD		Total
			1	2	
q33_PYSOC	1	Count	0	3	3
		% within q33_PYSOC	0,0%	100,0%	100,0%
		% within qmNEW17_MSD	0,0%	27,3%	8,8%
		% of Total	0,0%	8,8%	8,8%
	2	Count	23	8	31
		% within q33_PYSOC	74,2%	25,8%	100,0%
		% within qmNEW17_MSD	100,0%	72,7%	91,2%
		% of Total	67,6%	23,5%	91,2%
Total		Count	23	11	34
		% within q33_PYSOC	67,6%	32,4%	100,0%
		% within qmNEW17_MSD	100,0%	100,0%	100,0%
		% of Total	67,6%	32,4%	100,0%

qmNEW17_MSD: Symptoms in the shoulders the last 12 months (any symptom)

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	6,880[a]	1	,009		
Continuity Correction[b]	3,907	1	,048		
Likelihood Ratio	7,403	1	,007		
Fisher's Exact Test				,028	,028
Linear-by-Linear Association	6,677	1	,010		
N of Valid Cases	34				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is ,97.

b. Computed only for a 2x2 table

Q34: Comments taken into account on performance monitoring

Crosstab

			qmNEW20_MSD		Total
			1,00	2,00	
q34_PYSOC	1	Count	2	2	4
		% within q34_PYSOC	50,0%	50,0%	100,0%
		% within qmNEW20_MSD	5,9%	100,0%	11,1%
		% of Total	5,6%	5,6%	11,1%
	2	Count	32	0	32
		% within q34_PYSOC	100,0%	0,0%	100,0%
		% within qmNEW20_MSD	94,1%	0,0%	88,9%
		% of Total	88,9%	0,0%	88,9%
Total		Count	34	2	36
		% within q34_PYSOC	94,4%	5,6%	100,0%
		% within qmNEW20_MSD	100,0%	100,0%	100,0%
		% of Total	94,4%	5,6%	100,0%

qmNEW20_MSD: Symptoms in the elbows the last 12 months (any symptom)

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	16,941[a]	1	,000		
Continuity Correction[b]	8,752	1	,003		
Likelihood Ratio	9,903	1	,002		
Fisher's Exact Test				,010	,010
Linear-by-Linear Association	16,471	1	,000		
N of Valid Cases	36				

a. 3 cells (75,0%) have expected count less than 5. The minimum expected count is ,22.

b. Computed only for a 2x2 table

Q34: Comments taken into account on performance monitoring

Crosstab

			qm22_MSD		Total
			1	2	
q34_PYSOC	1	Count	2	2	4
		% within q34_PYSOC	50,0%	50,0%	100,0%
		% within qm22_MSD	5,9%	100,0%	11,1%
		% of Total	5,6%	5,6%	11,1%
	2	Count	32	0	32
		% within q34_PYSOC	100,0%	0,0%	100,0%
		% within qm22_MSD	94,1%	0,0%	88,9%
		% of Total	88,9%	0,0%	88,9%
Total		Count	34	2	36
		% within q34_PYSOC	94,4%	5,6%	100,0%
		% within qm22_MSD	100,0%	100,0%	100,0%
		% of Total	94,4%	5,6%	100,0%

qm22: Symptoms in the elbows the last 7 days

Q
Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	16,941[a]	1	,000		
Continuity Correction[b]	8,752	1	,003		
Likelihood Ratio	9,903	1	,002		
Fisher's Exact Test				,010	,010
Linear-by-Linear Association	16,471	1	,000		
N of Valid Cases	36				

a. 3 cells (75,0%) have expected count less than 5. The minimum expected count is ,22.
b. Computed only for a 2x2 table

10.6.8 Logistic Regression tables for the MSD questionnaire (Call centres)

1. *DEPENDENT VARIABLE QM16: Neck symptoms the last 7 days*

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	q45:Job stress	1,119	,610	3,372	1	,066	3,063	,927	10,115
	Q11_Q12: Control of work pacing	-,170	,546	,097	1	,755	,843	,289	2,459
	Constant	-5,186	3,523	2,167	1	,141	,006		

a. Variable(s) entered on step 1: Job stress, Control of work pacing.

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	q45_PYSOC	1,216	,543	5,004	1	,025	3,372	1,162	9,782
	Constant	-6,041	2,345	6,635	1	,010	,002		

a. Variable(s) entered on step 1: Job stress.

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	q45: Job stress	,720	,337	4,552	1	,033	2,054	1,060	3,978
	Constant	-3,323	1,312	6,414	1	,011	,036		

a. Variable(s) entered on step 1: Job stress.

2. *DEPENDENT qmNEW17_MSD: Pain in the shoulders the last 12 months*

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	q45_PYSOC	,480	,354	1,843	1	,175	1,617	,808	3,234
	q33_PYSOC	-21,485	28420,636	,000	1	,999	,000	,000	.
	Constant	40,286	56841,272	,000	1	,999	3,134E+17		

a. Variable(s) entered on step 1: q45_PYSOC, q33_PYSOC.

3. *DEPENDENT qm19_MSD: Symptoms in the shoulders the last 7 days*

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	q45: Job stress	,995	,511	3,795	1	,051	2,704	,994	7,358
	Constant	-5,345	2,186	5,977	1	,014	,005		

a. Variable(s) entered on step 1: Job stress.

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4. DEPENDENT MSDqm17_18_19

Variables in the Equation

4. *DEPENDENT MSDqm17_18_19: Combination symptoms in shoulders*

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	q45:	,480	,354	1,843	1	,175	1,617	,808	3,234
	q33:	-21,485	28420,636	,000	1	,999	,000	,000	.
	Constant	40,286	56841,272	,000	1	,999	313448191901317890,000		

a. Variable(s) entered on step 1: q45: Job stress, q33: Consultation during performance control.

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	q45_PYSOC	,720	,337	4,552	1	,033	2,054	1,060	3,978
	Constant	-3,323	1,312	6,414	1	,011	,036		

a. Variable(s) entered on step 1: q45: Job stress

5. *DEPENDENT qmNEW20 or qm22 ή qm20-21-22 give the same results since they have the same values*

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	q34_PYSOC	-21,203	7105,180	,000	1	,998	,000	,000	.
	Constant	21,203	7105,180	,000	1	,998	1615474873		

a. Variable(s) entered on step 1: q34_PYSOC.

Q34: Observations during consultation for performance monitoring

6. *DEPENDENT qm37: Symptoms in the knees the last 7 days*

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	q34_PYSOC	-21,203	7105,180	,000	1	,998	,000	,000	.
	Constant	21,203	7105,180	,000	1	,998	1615474876		

a. Variable(s) entered on step 1: q34_PYSOC.

Q34: Observations during consultation for performance monitoring

10.6.9 Correlation table for Job stress and psychosocial factors (Manufacturing), 1

Correlations

			q45_	q39_	q40	q41_	q42_	q43_	q44_	Q1_Q2	Q3_Q4	Q5_Q6	Q7_Q8
Spearman's rho	q45_PYSOC	Correlation Coefficient	1,000	-,037	,137	-,228	-,005	-,118	,221	,248*	,022	-,276*	,123
		Sig. (2-tailed)	.	,773	,286	,127	,975	,361	,081	,046	,862	,029	,329
		N	65	64	63	46	41	62	63	65	65	63	65
	q39_PYSOC	Correlation Coefficient	-,037	1,000	,399**	-,133	-,207	,065	-,277*	,269*	-,066	,250*	-,020
		Sig. (2-tailed)	,773	.	,001	,379	,194	,620	,029	,031	,604	,049	,874
		N	64	64	63	46	41	61	62	64	64	63	64
	q40_PYSOC	Correlation Coefficient	,137	,399**	1,000	-,186	,108	,085	-,006	,548**	-,227	,241	,325**
		Sig. (2-tailed)	,286	,001	.	,222	,500	,517	,966	,000	,074	,059	,009
		N	63	63	63	45	41	60	61	63	63	62	63
	q41_PYSOC	Correlation Coefficient	-,228	-,133	-,186	1,000	-,036	-,041	,098	-,242	,075	-,103	,153
		Sig. (2-tailed)	,127	,379	,222	.	,824	,792	,526	,105	,620	,496	,309
		N	46	46	45	46	41	44	44	46	46	46	46
	q42_PYSOC	Correlation Coefficient	-,005	-,207	,108	-,036	1,000	,120	,145	,059	,079	-,073	-,020
		Sig. (2-tailed)	,975	,194	,500	,824	.	,456	,365	,712	,624	,650	,900
		N	41	41	41	41	41	41	41	41	41	41	41
	q43_PYSOC	Correlation Coefficient	-,118	,065	,085	-,041	,120	1,000	,267*	,141	-,274*	,364**	,234
		Sig. (2-tailed)	,361	,620	,517	,792	,456	.	,038	,274	,031	,004	,067
		N	62	61	60	44	41	62	61	62	62	60	62
	q44_PYSOC	Correlation Coefficient	,221	-,277*	-,006	,098	,145	,267*	1,000	-,151	-,250*	,047	,245

		Sig. (2-tailed)	,081	,029	,966	,526	,365	,038	.	,237	,048	,721	,053
		N	63	62	61	44	41	61	63	63	63	61	63
	Q1_Q2	Correlation Coefficient	,248*	,269*	,548**	-,242	,059	,141	-,151	1,000	,071	-,016	,165
		Sig. (2-tailed)	,046	,031	,000	,105	,712	,274	,237	.	,572	,903	,188
		N	65	64	63	46	41	62	63	65	65	63	65
	Q3_Q4	Correlation Coefficient	,022	-,066	-,227	,075	,079	-,274*	-,250*	,071	1,000	-,262*	-,107
		Sig. (2-tailed)	,862	,604	,074	,620	,624	,031	,048	,572	.	,038	,395
		N	65	64	63	46	41	62	63	65	65	63	65
	Q5_Q6	Correlation Coefficient	-,276*	,250*	,241	-,103	-,073	,364**	,047	-,016	-,262*	1,000	,223
		Sig. (2-tailed)	,029	,049	,059	,496	,650	,004	,721	,903	,038	.	,079
		N	63	63	62	46	41	60	61	63	63	63	63
	Q7_Q8	Correlation Coefficient	,123	-,020	,325**	,153	-,020	,234	,245	,165	-,107	,223	1,000
		Sig. (2-tailed)	,329	,874	,009	,309	,900	,067	,053	,188	,395	,079	.
		N	65	64	63	46	41	62	63	65	65	63	65

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

10.6.9 Correlation table for Job stress and psychosocial factors (Manufacturing), 2

Correlations

			q45_PYSOC	Q10_Q13	Q11_Q12	Q18_Q19	Q20_Q21	Q23_Q24_Q25	Q26_Q27	Q28_Q29
Spearman's rho	q45_PYSOC	Correlation Coefficient	1,000	,008	-,187	,076	,088	,161	-,033	,037
		Sig. (2-tailed)	.	,952	,135	,546	,490	,208	,794	,767
		N	65	64	65	65	64	63	65	65
	Q10_Q13	Correlation Coefficient	,008	1,000	,372**	-,020	,110	,167	,252*	,155
		Sig. (2-tailed)	,952	.	,003	,877	,390	,192	,044	,220
		N	64	64	64	64	63	63	64	64
	Q11_Q12	Correlation Coefficient	-,187	,372**	1,000	-,025	,018	,250*	,348**	,097
		Sig. (2-tailed)	,135	,003	.	,845	,891	,048	,004	,440
		N	65	64	65	65	64	63	65	65
	Q18_Q19	Correlation Coefficient	,076	-,020	-,025	1,000	,617**	,121	,311*	,455**
		Sig. (2-tailed)	,546	,877	,845	.	,000	,344	,012	,000
		N	65	64	65	65	64	63	65	65
	Q20_Q21	Correlation Coefficient	,088	,110	,018	,617**	1,000	-,055	,357**	,312*
		Sig. (2-tailed)	,490	,390	,891	,000	.	,671	,004	,012
		N	64	63	64	64	64	62	64	64
	Q23_Q24_Q25	Correlation Coefficient	,161	,167	,250*	,121	-,055	1,000	,169	,041
		Sig. (2-tailed)	,208	,192	,048	,344	,671	.	,186	,752
		N	63	63	63	63	62	63	63	63
	Q26_Q27	Correlation Coefficient	-,033	,252*	,348**	,311*	,357**	,169	1,000	,493**

		Sig. (2-tailed)	,794	,044	,004	,012	,004	,186	.	,000
		N	65	64	65	65	64	63	65	65
	Q28_Q29	Correlation Coefficient	,037	,155	,097	,455**	,312*	,041	,493**	1,000
		Sig. (2-tailed)	,767	,220	,440	,000	,012	,752	,000	.
		N	65	64	65	65	64	63	65	65

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

10.6.9 Correlation table for Job stress and psychosocial factors (Manufacturing), 3

Correlations

			q45_PYSOC	Q43_Q44	Q17_Q18_Q19	Q37_Q38	Q39_Q40
Spearman's rho	q45_PYSOC	Correlation Coefficient	1,000	,104	,067	,311*	,046
		Sig. (2-tailed)	.	,412	,596	,013	,716
		N	65	64	65	63	64
	Q43_Q44	Correlation Coefficient	,104	1,000	,218	-,041	-,145
		Sig. (2-tailed)	,412	.	,083	,751	,255
		N	64	64	64	62	63
	Q17_Q18_Q19	Correlation Coefficient	,067	,218	1,000	-,305*	,178
		Sig. (2-tailed)	,596	,083	.	,015	,158
		N	65	64	65	63	64
	Q37_Q38	Correlation Coefficient	,311*	-,041	-,305*	1,000	-,057
		Sig. (2-tailed)	,013	,751	,015	.	,660
		N	63	62	63	63	63
	Q39_Q40	Correlation Coefficient	,046	-,145	,178	-,057	1,000
		Sig. (2-tailed)	,716	,255	,158	,660	.
		N	64	63	64	63	64

*. Correlation is significant at the 0.05 level (2-tailed).

10.6.9 Correlation table for Job stress and psychosocial factors (Manufacturing), 4

Correlations

			q45_	q1_	q2_	q3_	q4_	q5_	q6_	q7_	q8_	q9_	q10_
Spearman's rho	q45_PYSOC	Correlation Coefficient	1,000	,131	,342**	,093	,005	-,269*	-,213	,126	,087	-,028	,002
		Sig. (2-tailed)	.	,301	,005	,460	,969	,033	,094	,328	,489	,825	,990
		N	65	64	65	65	65	63	63	62	65	64	60
	q1_PYSOC	Correlation Coefficient	,131	1,000	,372**	,236	-,062	-,058	-,167	-,055	-,006	,156	,316*
		Sig. (2-tailed)	,301	.	,002	,060	,628	,652	,194	,671	,965	,223	,015
		N	64	64	64	64	64	62	62	61	64	63	59
	q2_PYSOC	Correlation Coefficient	,342**	,372**	1,000	,195	-,077	,024	,161	,364**	,444**	-,011	,034
		Sig. (2-tailed)	,005	,002	.	,119	,544	,850	,206	,004	,000	,930	,796
		N	65	64	65	65	65	63	63	62	65	64	60
	q3_PYSOC	Correlation Coefficient	,093	,236	,195	1,000	,033	-,268*	-,093	,153	,120	,318*	,138
		Sig. (2-tailed)	,460	,060	,119	.	,796	,034	,470	,235	,343	,010	,293
		N	65	64	65	65	65	63	63	62	65	64	60
	q4_PYSOC	Correlation Coefficient	,005	-,062	-,077	,033	1,000	-,135	-,144	-,131	-,290*	,062	-,080
		Sig. (2-tailed)	,969	,628	,544	,796	.	,291	,259	,310	,019	,626	,543

	N	65	64	65	65	65	63	63	62	65	64	60
q5_PYSOC	Correlation Coefficient	-,269*	-,058	,024	-,268*	-,135	1,000	,603**	,097	,151	-,181	,121
	Sig. (2-tailed)	,033	,652	,850	,034	,291	.	,000	,457	,239	,159	,355
	N	63	62	63	63	63	63	63	61	63	62	60
q6_PYSOC	Correlation Coefficient	-,213	-,167	,161	-,093	-,144	,603**	1,000	,345**	,164	-,204	,102
	Sig. (2-tailed)	,094	,194	,206	,470	,259	,000	.	,006	,199	,112	,436
	N	63	62	63	63	63	63	63	61	63	62	60
q7_PYSOC	Correlation Coefficient	,126	-,055	,364**	,153	-,131	,097	,345**	1,000	,690**	-,259*	,047
	Sig. (2-tailed)	,328	,671	,004	,235	,310	,457	,006	.	,000	,044	,725
	N	62	61	62	62	62	61	61	62	62	61	59
q8_PYSOC	Correlation Coefficient	,087	-,006	,444**	,120	-,290*	,151	,164	,690**	1,000	-,245	-,002
	Sig. (2-tailed)	,489	,965	,000	,343	,019	,239	,199	,000	.	,051	,986
	N	65	64	65	65	65	63	63	62	65	64	60
q9_PYSOC	Correlation Coefficient	-,028	,156	-,011	,318*	,062	-,181	-,204	-,259*	-,245	1,000	,230
	Sig. (2-tailed)	,825	,223	,930	,010	,626	,159	,112	,044	,051	.	,079
	N	64	63	64	64	64	62	62	61	64	64	59
q10_PYSOC	Correlation Coefficient	,002	,316*	,034	,138	-,080	,121	,102	,047	-,002	,230	1,000

	Sig. (2-tailed)	,990	,015	,796	,293	,543	,355	,436	,725	,986	,079	.
	N	60	59	60	60	60	60	60	59	60	59	60

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

10.6.9 Correlation table for Job stress and psychosocial factors (Manufacturing), 4

10.6.9 Correlation table for Job stress and psychosocial factors (Manufacturing), 5

Correlations

			q45_	q11_	q12_	q13_	q14_	q15_	q16_	q17_	q18_	q19_	q20_
Spearman's rho	q45_PYSOC	Correlation Coefficient	1,000	-,114	-,222	,051	-,049	-,044	-,146	-,091	,137	,015	,029
		Sig. (2-tailed)	.	,366	,075	,692	,696	,734	,252	,474	,275	,909	,820
		N	65	65	65	63	65	63	63	64	65	65	64
	q11_PYSOC	Correlation Coefficient	-,114	1,000	,376**	,135	,087	-,024	,015	,093	,009	-,017	,001
		Sig. (2-tailed)	,366	.	,002	,291	,491	,853	,908	,466	,941	,892	,997
		N	65	65	65	63	65	63	63	64	65	65	64
	q12_PYSOC	Correlation Coefficient	-,222	,376**	1,000	,223	,240	-,142	,234	,315*	-,017	,045	,216
		Sig. (2-tailed)	,075	,002	.	,078	,054	,267	,065	,011	,892	,723	,086
		N	65	65	65	63	65	63	63	64	65	65	64
	q13_PYSOC	Correlation Coefficient	,051	,135	,223	1,000	-,002	-,242	,152	,206	,024	,075	,174
		Sig. (2-tailed)	,692	,291	,078	.	,988	,058	,240	,108	,852	,562	,175
		N	63	63	63	63	63	62	62	62	63	63	62
	q14_PYSIC	Correlation Coefficient	-,049	,087	,240	-,002	1,000	-,219	,090	,062	,162	,050	-,041
		Sig. (2-tailed)	,696	,491	,054	,988	.	,085	,485	,626	,197	,692	,748
		N	65	65	65	63	65	63	63	64	65	65	64

	q15_PYSOC	Correlation Coefficient	-,044	-,024	-,142	-,242	-,219	1,000	,079	-,018	-,019	-,099	,038
		Sig. (2-tailed)	,734	,853	,267	,058	,085	.	,541	,892	,883	,441	,769
		N	63	63	63	62	63	63	62	62	63	63	62
	q16_PYSOC	Correlation Coefficient	-,146	,015	,234	,152	,090	,079	1,000	,402**	,002	,155	,253*
		Sig. (2-tailed)	,252	,908	,065	,240	,485	,541	.	,001	,990	,226	,047
		N	63	63	63	62	63	62	63	62	63	63	62
	q17_PYSOC	Correlation Coefficient	-,091	,093	,315*	,206	,062	-,018	,402**	1,000	,361**	-,020	,197
		Sig. (2-tailed)	,474	,466	,011	,108	,626	,892	,001	.	,003	,877	,121
		N	64	64	64	62	64	62	62	64	64	64	63
	q18_PYSOC	Correlation Coefficient	,137	,009	-,017	,024	,162	-,019	,002	,361**	1,000	,500**	,377**
		Sig. (2-tailed)	,275	,941	,892	,852	,197	,883	,990	,003	.	,000	,002
		N	65	65	65	63	65	63	63	64	65	65	64
	q19_PYSOC	Correlation Coefficient	,015	-,017	,045	,075	,050	-,099	,155	-,020	,500**	1,000	,488**
		Sig. (2-tailed)	,909	,892	,723	,562	,692	,441	,226	,877	,000	.	,000
		N	65	65	65	63	65	63	63	64	65	65	64
	q20_PYSOC	Correlation Coefficient	,029	,001	,216	,174	-,041	,038	,253*	,197	,377**	,488**	1,000
		Sig. (2-tailed)	,820	,997	,086	,175	,748	,769	,047	,121	,002	,000	.

N	64	64	64	62	64	62	62	63	64	64	64

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

10.6.10 Control of statistically significant differences between job stress and performance monitoring (manufacturing)

Case Summaries

q45_PYSOC Job stress

q32_PYSOC Information for performance monitoring	N	Mean	Median	Minimum	Maximum	Std. Deviation
1 yes	33	2,61	3,00	1 Not at all	4 rather much	,933
2 no	7	2,43	3,00	1 Not at all	3 to some extend	,787
Total	40	2,58	3,00	1 Not at all	4 rather much	,903

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	105,000
Wilcoxon W	133,000
Z	-,395
Asymp. Sig. (2-tailed)	,693
Exact Sig. [2*(1-tailed Sig.)]	,728[b]

a. Grouping Variable: q32_PYSOC Information for performance monitoring
b. Not corrected for ties.

Case Summaries

q45_PYSOC Job stress

q33_PYSOC Consultation during performance monitoring	N	Mean	Median	Minimum	Maximum	Std. Deviation
1 yes	28	2,46	2,50	1 not at all	4 rather much	,881
2 no	11	2,73	3,00	1 not at all	4 rather much	,905
Total	39	2,54	3,00	1 not at all	4 rather much	,884

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	128,500
Wilcoxon W	534,500
Z	-,843
Asymp. Sig. (2-tailed)	,399
Exact Sig. [2*(1-tailed Sig.)]	,432[b]

a. Grouping Variable: q33_PYSOC Consultation during performance monitoring
b. Not corrected for ties.

Case Summaries

q45_PYSOC Job stress

q34_PYSOC Comments taken into account	N	Mean	Median	Minimum	Maximum	Std. Deviation
1 yes	28	2,50	2,50	1 Not at all	4 rather much	,923
2 no	10	2,70	3,00	1 Not at all	4 rather much	,823
Total	38	2,55	3,00	1 Not at all	4 rather much	,891

Test Statistics[a]

	q45_PYSOC Job stress
Mann-Whitney U	120,000
Wilcoxon W	526,000
Z	-,703
Asymp. Sig. (2-tailed)	,482
Exact Sig. [2*(1-tailed Sig.)]	,524[b]

a. Grouping Variable: q34_PYSOC Comments taken into account
b. Not corrected for ties.

Case Summaries

q45_PYSOC Job stress

q35_PYSOC Are your immediate superiors trained to judge your performance on a prescribed way, fair and confidentially?	N	Mean	Median	Minimum	Maximum	Std. Deviation
1 yes	32	2,56	2,50	1 not at all	4 rather much	,948
2 no	8	3,12	3,00	2 only a little	5 very much	,835
Total	40	2,68	3,00	1 not at all	5 very much	,944

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	88,000
Wilcoxon W	616,000
Z	-1,427
Asymp. Sig. (2-tailed)	,153
Exact Sig. [2*(1-tailed Sig.)]	,185[b]

a. Grouping Variable: q35_PYSOC Are your immediate superiors trained to judge your performance on a prescribed way, fair and confidentially?
b. Not corrected for ties.

10.6.11 Correlation table for Job satisfaction and Psychosocial factors (Manufacturing)

Correlations

			Q43_Q44	Q1_Q2	Q3_Q4	Q5_Q6	Q7_Q8	q9_PYSOC	Q10_Q13	Q11_Q12	q14_PYSIC	q16_PYSOC	q17_PYSOC	Q18_Q19	Q20_Q21	q22_PYSOC	Q23_Q24_Q25	Q26_Q27	Q28_Q29	q30_PYSOC	q31_PYSOC	q36_PYSOC
Spearman's rho	Q43_Q44	Correlation Coefficient	1,000	-,047	-,283*	,215	,314*	-,073	-,040	,049	-,001	,221	,221	,172	,138	-,041	,241	,271*	,127	-,267*	,369*	,203
		Sig. (2-tailed)	.	,712	,023	,094	,012	,568	,753	,698	,992	,085	,081	,173	,281	,748	,059	,030	,318	,034	,018	,113
		N	64	64	64	62	64	63	63	64	64	62	63	64	63	64	62	64	64	63	41	62
	Q1_Q2	Correlation Coefficient	-,047	1,000	,071	-,016	,165	,092	,335**	,425**	,249*	-,063	,007	-,080	-,015	,181	,393**	-,026	-,013	,225	,152	,174
		Sig. (2-tailed)	,712	.	,572	,903	,188	,469	,007	,000	,046	,626	,959	,528	,905	,148	,001	,837	,919	,074	,341	,172
		N	64	65	65	63	65	64	64	65	65	63	64	65	64	65	63	65	65	64	41	63
	Q3_Q4	Correlation Coefficient	-,283*	,071	1,000	-,262*	-,107	,248*	-,009	-,307*	-,038	-,183	-,151	-,038	-,236	-,038	,003	-,397**	-,186	,135	-,444**	-,229
		Sig. (2-tailed)	,023	,572	.	,038	,395	,048	,947	,013	,764	,152	,234	,763	,061	,763	,982	,001	,137	,288	,004	,071
		N	64	65	65	63	65	64	64	65	65	63	64	65	64	65	63	65	65	64	41	63
	Q5_Q6	Correlation Coefficient	,215	-,016	-,262*	1,000	,223	-,229	,211	,286*	,159	,213	,380**	,199	,300*	,023	,125	,445**	,474**	-,067	,413**	,100
		Sig. (2-tailed)	,094	,903	,038	.	,079	,073	,096	,023	,214	,097	,002	,117	,018	,860	,334	,000	,000	,603	,007	,442
		N	62	63	63	63	63	62	63	63	63	62	62	63	62	63	62	63	63	63	41	62
	Q7_Q8	Correlation Coefficient	,314*	,165	-,107	,223	1,000	-,256*	-,027	,071	,250*	,084	,289*	,214	,147	-,153	,325**	,329**	,220	-,166	,157	,236
		Sig. (2-tailed)	,012	,188	,395	,079	.	,041	,830	,572	,044	,514	,021	,087	,248	,224	,009	,008	,079	,190	,326	,062
		N	64	65	65	63	65	64	64	65	65	63	64	65	64	65	63	65	65	64	41	63
	q9_PYSOC	Correlation Coefficient	-,073	,092	,248*	-,229	-,256*	1,000	,133	,009	-,279*	,004	-,046	-,291*	-,141	,156	-,037	-,232	-,287*	,323**	-,034	-,430**
		Sig. (2-tailed)	,568	,469	,048	,073	,041	.	,299	,945	,026	,973	,720	,020	,271	,219	,775	,065	,021	,010	,836	,000
		N	63	64	64	62	64	64	63	64	64	62	63	64	63	64	62	64	64	63	40	62
	Q10_Q13	Correlation Coefficient	-,040	,335**	-,009	,211	-,027	,133	1,000	,372**	-,016	,165	,195	-,020	,110	,044	,167	,252*	,155	,326**	,387*	,082
		Sig. (2-tailed)	,753	,007	,947	,096	,830	,299	.	,003	,899	,196	,126	,877	,390	,730	,192	,044	,220	,008	,013	,524
		N	63	64	64	63	64	63	64	64	64	63	63	64	63	64	63	64	64	64	41	62
	Q11_Q12	Correlation Coefficient	,049	,425**	-,307*	,286*	,071	,009	,372**	1,000	,210	,156	,281*	-,025	,018	,280*	,250*	,348**	,097	,231	,243	,334**
		Sig. (2-tailed)	,698	,000	,013	,023	,572	,945	,003	.	,093	,223	,024	,845	,891	,024	,048	,004	,440	,066	,126	,007
		N	64	65	65	63	65	64	64	65	65	63	64	65	64	65	63	65	65	64	41	63
	q14_PYSIC	Correlation Coefficient	-,001	,249*	-,038	,159	,250*	-,279*	-,016	,210	1,000	,090	,062	,063	-,006	,186	,040	,184	,272*	-,113	-,174	,149
		Sig. (2-tailed)	,992	,046	,764	,214	,044	,026	,899	,093	.	,485	,626	,620	,959	,139	,753	,143	,028	,373	,276	,242
		N	64	65	65	63	65	64	64	65	65	63	64	65	64	65	63	65	65	64	41	63
	q16_PYSOC	Correlation Coefficient	,221	-,063	-,183	,213	,084	,004	,165	,156	,090	1,000	,402**	,105	,225	,258*	-,025	,429**	,134	-,115	,113	-,076
		Sig. (2-tailed)	,085	,626	,152	,097	,514	,973	,196	,223	,485	.	,001	,411	,079	,042	,845	,000	,293	,367	,486	,561
		N	62	63	63	62	63	62	63	63	63	63	62	63	62	63	62	63	63	63	40	61
	q17_PYSOC	Correlation Coefficient	,221	,007	-,151	,380**	,289*	-,046	,195	,281*	,062	,402**	1,000	,163	,242	,163	,169	,313*	,289*	-,064	,075	-,024
		Sig. (2-tailed)	,081	,959	,234	,002	,021	,720	,126	,024	,626	,001	.	,197	,056	,197	,189	,012	,021	,616	,644	,853
		N	63	64	64	62	64	63	63	64	64	62	64	64	63	64	62	64	64	63	40	62
	Q18_Q19	Correlation Coefficient	,172	-,080	-,038	,199	,214	-,291*	-,020	-,025	,063	,105	,163	1,000	,617**	,166	,121	,311*	,455**	-,379**	-,007	-,031
		Sig. (2-tailed)	,173	,528	,763	,117	,087	,020	,877	,845	,620	,411	,197	.	,000	,186	,344	,012	,000	,002	,964	,807
		N	64	65	65	63	65	64	64	65	65	63	64	65	64	65	63	65	65	64	41	63
	Q20_Q21	Correlation Coefficient	,138	-,015	-,236	,300*	,147	-,141	,110	,018	-,006	,225	,242	,617**	1,000	,290*	-,055	,357**	,312*	-,150	,249	-,070
		Sig. (2-tailed)	,281	,905	,061	,018	,248	,271	,390	,891	,959	,079	,056	,000	.	,020	,671	,004	,012	,242	,116	,587
		N	63	64	64	62	64	63	63	64	64	62	63	64	64	64	62	64	64	63	41	62
	q22_PYSOC	Correlation Coefficient	-,041	,181	-,038	,023	-,153	,156	,044	,280*	,186	,258*	,163	,166	,290*	1,000	-,012	,127	,122	-,044	-,140	-,192
		Sig. (2-tailed)	,748	,148	,763	,860	,224	,219	,730	,024	,139	,042	,197	,186	,020	.	,928	,314	,335	,730	,382	,132
		N	64	65	65	63	65	64	64	65	65	63	64	65	64	65	63	65	65	64	41	63
	Q23_Q24_Q25	Correlation Coefficient	,241	,393**	,003	,125	,325**	-,037	,167	,250*	,040	-,025	,169	,121	-,055	-,012	1,000	,169	,041	,090	,116	,376**
		Sig. (2-tailed)	,059	,001	,982	,334	,009	,775	,192	,048	,753	,845	,189	,344	,671	,928	.	,186	,752	,485	,476	,003
		N	62	63	63	62	63	62	63	63	63	62	62	63	62	63	63	63	63	63	40	61
	Q26_Q27	Correlation Coefficient	,271*	-,026	-,397**	,445**	,329**	-,232	,252*	,348**	,184	,429**	,313*	,311*	,357**	,127	,169	1,000	,493**	-,071	,311*	,172
		Sig. (2-tailed)	,030	,837	,001	,000	,008	,065	,044	,004	,143	,000	,012	,012	,004	,314	,186	.	,000	,575	,048	,179
		N	64	65	65	63	65	64	64	65	65	63	64	65	64	65	63	65	65	64	41	63
	Q28_Q29	Correlation Coefficient	,127	-,013	-,186	,474**	,220	-,287*	,155	,097	,272*	,134	,289*	,455**	,312*	,122	,041	,493**	1,000	-,366**	,123	,088
		Sig. (2-tailed)	,318	,919	,137	,000	,079	,021	,220	,440	,028	,293	,021	,000	,012	,335	,752	,000	.	,003	,443	,494
		N	64	65	65	63	65	64	64	65	65	63	64	65	64	65	63	65	65	64	41	63
	q30_PYSOC	Correlation Coefficient	-,267*	,225	,135	-,067	-,166	,323**	,326**	,231	-,113	-,115	-,064	-,379**	-,150	-,044	,090	-,071	-,366**	1,000	,082	,073
		Sig. (2-tailed)	,034	,074	,288	,603	,190	,010	,008	,066	,373	,367	,616	,002	,242	,730	,485	,575	,003	.	,610	,572
		N	63	64	64	63	64	63	64	64	64	63	63	64	63	64	63	64	64	64	41	62
	q31_PYSOC	Correlation Coefficient	,369*	,152	-,444**	,413**	,157	-,034	,387*	,243	-,174	,113	,075	-,007	,249	-,140	,116	,311*	,123	,082	1,000	,220
		Sig. (2-tailed)	,018	,341	,004	,007	,326	,836	,013	,126	,276	,486	,644	,964	,116	,382	,476	,048	,443	,610	.	,167
		N	41	41	41	41	41	40	41	41	41	40	40	41	41	41	40	41	41	41	41	41
	q36_PYSOC	Correlation Coefficient	,203	,174	-,229	,100	,236	-,430**	,082	,334**	,149	-,076	-,024	-,031	-,070	-,192	,376**	,172	,088	,073	,220	1,000
		Sig. (2-tailed)	,113	,172	,071	,442	,062	,000	,524	,007	,242	,561	,853	,807	,587	,132	,003	,179	,494	,572	,167	.
		N	62	63	63	62	63	62	62	63	63	61	62	63	62	63	61	63	63	62	41	63

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Pro
disc

10.6.12 Control of statistically significant differences between job satisfaction and performance monitoring (manufacturing)

Case Summaries

Job satisfaction

q32_PYSOC	N	Mean	Median	Minimum	Maximum	Std. Deviation
1	33	3,8030	4,0000	2,50	5,00	,58549
2	7	3,2143	3,0000	1,50	4,50	1,03510
Total	40	3,7000	4,0000	1,50	5,00	,70529

Test Statistics[a]

	Job satisfaction
Mann-Whitney U	76,000
Wilcoxon W	104,000
Z	-1,444
Asymp. Sig. (2-tailed)	,149
Exact Sig. [2*(1-tailed Sig.)]	,169[b]

a. Grouping Variable: q32_PYSOC: Information for the performance monitoring method
b. Not corrected for ties.

Case Summaries

Job satisfaction

q33_PYSOC	N	Mean	Median	Minimum	Maximum	Std. Deviation
1	28	3,7500	3,7500	2,50	5,00	,60093
2	11	3,5909	4,0000	1,50	4,50	,97000
Total	39	3,7051	4,0000	1,50	5,00	,71376

Test Statistics[a]

	Job satisfaction
Mann-Whitney U	153,000
Wilcoxon W	219,000
Z	-,032
Asymp. Sig. (2-tailed)	,974
Exact Sig. [2*(1-tailed Sig.)]	,988[b]

a. Grouping Variable: q33_PYSOC: Consultation during the performance monitoring
b. Not corrected for ties.

Case Summaries

Job satisfaction

q34_PYSOC	N	Mean	Median	Minimum	Maximum	Std. Deviation
1	28	3,6786	3,5000	2,50	5,00	,58078
2	10	3,7000	4,0000	1,50	4,50	1,03280
Total	38	3,6842	4,0000	1,50	5,00	,71112

Test Statistics[a]

	Job satisfaction
Mann-Whitney U	115,000
Wilcoxon W	521,000
Z	-,852
Asymp. Sig. (2-tailed)	,394
Exact Sig. [2*(1-tailed Sig.)]	,423[b]

a. Grouping Variable: q34_PYSOC: Comments taken into account
b. Not corrected for ties.

Case Summaries

Job satisfaction

q35_PYSOC	N	Mean	Median	Minimum	Maximum	Std. Deviation
1	32	3,7344	3,7500	2,50	5,00	,58177
2	8	3,5625	4,0000	1,50	4,50	1,11604
Total	40	3,7000	4,0000	1,50	5,00	,70529

Test Statistics[a]

	Job satisfaction
Mann-Whitney U	124,000
Wilcoxon W	652,000
Z	-,139
Asymp. Sig. (2-tailed)	,890
Exact Sig. [2*(1-tailed Sig.)]	,908[b]

a. Grouping Variable: q35_PYSOC: Are your immediate superiors trained to judge your performance on a predescribed way, fair and confidentially?
b. Not corrected for ties.

10.6.13 Regression tables for the Psychosocial Questionnaire (Manufacturing)

10.6.13.1 Regression tables for job stress (Manufacturing)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,480[a]	,230	,172	,966

a. Predictors: (Constant), q38_PYSOC, q25_PYSOC, Q1_Q2, Q5_Q6
b. Dependent Variable: Job stress

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14,782	4	3,695	3,961	,007[a]
	Residual	49,443	53	,933		
	Total	64,224	57			

a. Predictors: (Constant), q38_PYSOC, q25_PYSOC, Q1_Q2, Q5_Q6
b. Dependent Variable: Job stress

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	2,290	,871		2,630	,011	,544	4,036		
	Q1_Q2	,142	,168	,110	,849	,399	-,194	,479	,873	1,145
	Q5_Q6	-,248	,166	-,215	-1,497	,140	-,581	,084	,705	1,419
	q25_PYSOC	,273	,102	,343	2,682	,010	,069	,477	,890	1,123
	q38_PYSOC	,037	,141	,040	,261	,795	-,246	,319	,632	1,582

a. Dependent Variable: Job stress

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	1,70	3,68	2,43	,509	58
Residual	-1,966	2,136	,000	,931	58
Std. Predicted Value	-1,443	2,461	,000	1,000	58
Std. Residual	-2,036	2,211	,000	,964	58

a. Dependent Variable: Job stress

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,396[a]	,157	,142	,983
2	,465[b]	,217	,188	,956

a. Predictors: (Constant), Rigid and rule-based climate
b. Predictors: (Constant), Rigid and rule-based climate, Learning demands
c. Dependent Variable: Job stress

ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10,066	1	10,066	10,409	,002[a]
	Residual	54,158	56	,967		
	Total	64,224	57			
2	Regression	13,909	2	6,955	7,602	,001[b]
	Residual	50,315	55	,915		
	Total	64,224	57			

a. Predictors: (Constant), Rigid and rule-based climate
b. Predictors: (Constant), Rigid and rule-based climate, Learning demands
c. Dependent Variable: Job stress

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	1,687	,264		6,381	,000	1,157	2,216		
	q25_PYSOC	,315	,098	,396	3,226	,002	,119	,511	1,000	1,000
2	(Constant)	2,814	,607		4,634	,000	1,597	4,031		
	q25_Rigid and rule-based climate	,303	,095	,380	3,179	,002	,112	,493	,996	1,004
	Positive Challenges (Q5_Q6)	-,283	,138	-,245	-2,050	,045	-,560	-,006	,996	1,004

a. Dependent Variable: Job stress

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	1,70	3,44	2,44	,491	59
Residual	-2,054	2,127	,004	,932	59
Std. Predicted Value	-1,477	2,041	,011	,995	59
Std. Residual	-2,147	2,224	,004	,974	59

a. Dependent Variable: Job stress

10.6.13.2 Regression tables for Job satisfaction (Manufacturing)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,560[a]	,314	,216	,62012

a. Predictors: (Constant), Q26_Q27, q30_PYSOC, Q7_Q8, Q3_Q4, q31_PYSOC
b. Dependent Variable: Job satisfaction

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6,163	5	1,233	3,205	,017[a]
	Residual	13,459	35	,385		
	Total	19,622	40			

a. Predictors: (Constant), Q26_Q27, q30_PYSOC, Q7_Q8, Q3_Q4, q31_PYSOC
b. Dependent Variable: Job satisfaction

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	3,286	1,116		2,945	,006	1,021	5,551		
	Q7_Q8	,123	,131	,141	,944	,352	-,142	,389	,881	1,136
	Q3_Q4	-,374	,184	-,316	-2,029	,050	-,747	,000	,810	1,235
	q30_PYSOC	-,113	,116	-,142	-,970	,339	-,349	,123	,914	1,094
	q31_PYSOC	,077	,099	,124	,779	,441	-,124	,279	,773	1,293
	Q26_Q27	,179	,196	,150	,915	,367	-,218	,576	,728	1,375

a. Dependent Variable: Job satisfaction

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	2,5707	4,3248	3,6463	,39251	41
Residual	-1,46443	1,28888	,00000	,58007	41
Std. Predicted Value	-2,740	1,728	,000	1,000	41
Std. Residual	-2,362	2,078	,000	,935	41

a. Dependent Variable: Job satisfaction

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,449[a]	,202	,181	,63379

a. Predictors: (Constant), Learning demands
b. Dependent Variable: Job satisfaction

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3,956	1	3,956	9,848	,003[a]
	Residual	15,666	39	,402		
	Total	19,622	40			

a. Predictors: (Constant), Learning demands
b. Dependent Variable: Job satisfaction

Coefficients[a]

Model		Unstandardized Co-efficients		Standard-ized Coeffi-cients	t	Sig.	95,0% Confidence Inter-val for B		Collinearity Statis-tics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Toler-ance	VIF
1	(Constant)	4,903	,413		11,883	,000	4,069	5,738		
	Learning demands: (Q3_Q4)	-,531	,169	-,449	-3,138	,003	-,874	-,189	1,000	1,000

a. Dependent Variable: Job satisfaction

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	3,0437	4,3721	3,6913	,34744	64
Residual	-1,84073	1,19060	-,08192	,70231	64
Std. Predicted Value	-1,916	2,308	,143	1,105	64
Std. Residual	-2,904	1,879	-,129	1,108	64

a. Dependent Variable: Job satisfaction

10.6.14 Control for statistically significant differences in the MSD Questionnaire (Manufacturing)

10.6.14.1 Control for statistically significant differences between Job stress and MSD symptoms (Manufacturing)

Case Summaries

q45_Job stress

qmNEW17_MSD	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	20	2,05	2,00	,759	1	4
2	5	2,80	3,00	,447	2	3
Total	25	2,20	2,00	,764	1	4

qmNEW17_MSD: Symptoms in the shoulders the last 12 months (any symptom)

Test Statistics[a]

	Job stress
Mann-Whitney U	20,000
Wilcoxon W	230,000
Z	-2,231
Asymp. Sig. (2-tailed)	,026
Exact Sig. [2*(1-tailed Sig.)]	,042[b]

a. Grouping Variable: qmNEW17_MSD:

b. Not corrected for ties.

Case Summaries

q45_Job stress

MSDqm17_18_19	N	Mean	Median	Std. Deviation	Minimum	Maximum
1	20	2,05	2,00	,759	1	4
2	5	2,80	3,00	,447	2	3
Total	25	2,20	2,00	,764	1	4

MSDqm17_18_19: Combination symptoms in the shoulders

Test Statistics[a]

	q45_Job stress
Mann-Whitney U	20,000
Wilcoxon W	230,000
Z	-2,231
Asymp. Sig. (2-tailed)	,026
Exact Sig. [2*(1-tailed Sig.)]	,042[b]

a. Grouping Variable: MSDqm17_18_19: b. Not corrected for ties.

10.6.14.2 Control for statistically significant differences between performance monitoring and MSD symptoms (Manufacturing)

Q32: Information about the performance monitoring

Crosstab

			qm14_MSD		Total
			1	2	
q32_PYSOC	1	Count	17	1	18
		% within q32_PYSOC	94,4%	5,6%	100,0%
		% within qm14_MSD	94,4%	33,3%	85,7%
		% of Total	81,0%	4,8%	85,7%
	2	Count	1	2	3
		% within q32_PYSOC	33,3%	66,7%	100,0%
		% within qm14_MSD	5,6%	66,7%	14,3%
		% of Total	4,8%	9,5%	14,3%
Total		Count	18	3	21
		% within q32_PYSOC	85,7%	14,3%	100,0%
		% within qm14_MSD	100,0%	100,0%	100,0%
		% of Total	85,7%	14,3%	100,0%

qm14: Symptoms the last 12 months in the neck

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	7,843[a]	1	,005		
Continuity Correction[b]	3,646	1	,056		
Likelihood Ratio	5,682	1	,017		
Fisher's Exact Test				,041	,041
Linear-by-Linear Association	7,469	1	,006		
N of Valid Cases	21				

a. 3 cells (75,0%) have expected count less than 5. The minimum expected count is ,43.
b. Computed only for a 2x2 table

Q32: Information about the performance monitoring

Crosstab

			qmNEW17_MSD		Total
			1	2	
q32_PYSOC	1	Count	18	2	20
		% within q32_PYSOC	90,0%	10,0%	100,0%
		% within qmNEW17_MSD	100,0%	50,0%	90,9%
		% of Total	81,8%	9,1%	90,9%
	2	Count	0	2	2
		% within q32_PYSOC	0,0%	100,0%	100,0%
		% within qmNEW17_MSD	0,0%	50,0%	9,1%
		% of Total	0,0%	9,1%	9,1%
Total		Count	18	4	22
		% within q32_PYSOC	81,8%	18,2%	100,0%
		% within qmNEW17_MSD	100,0%	100,0%	100,0%
		% of Total	81,8%	18,2%	100,0%

qmNEW17: Symptoms the last 12 months in the shoulders (any symptom)

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	9,900[a]	1	,002		
Continuity Correction[b]	4,774	1	,029		
Likelihood Ratio	7,859	1	,005		
Fisher's Exact Test				,026	,026
Linear-by-Linear Association	9,450	1	,002		
N of Valid Cases	22				

a. 3 cells (75,0%) have expected count less than 5. The minimum expected count is ,36.
b. Computed only for a 2x2 table

Q33: Consultation during the performance monitoring

Crosstab

			qm14_MSD		Total
			1	2	
q33_PYSOC	1	Count	17	1	18
		% within q33_PYSOC	94,4%	5,6%	100,0%
		% within qm14_MSD	94,4%	33,3%	85,7%
		% of Total	81,0%	4,8%	85,7%
	2	Count	1	2	3
		% within q33_PYSOC	33,3%	66,7%	100,0%
		% within qm14_MSD	5,6%	66,7%	14,3%
		% of Total	4,8%	9,5%	14,3%
Total		Count	18	3	21
		% within q33_PYSOC	85,7%	14,3%	100,0%
		% within qm14_MSD	100,0%	100,0%	100,0%
		% of Total	85,7%	14,3%	100,0%

qm14: Symptoms the last 12 months in the neck

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	7,843[a]	1	,005		
Continuity Correction[b]	3,646	1	,056		
Likelihood Ratio	5,682	1	,017		
Fisher's Exact Test				,041	,041
Linear-by-Linear Association	7,469	1	,006		
N of Valid Cases	21				

a. 3 cells (75,0%) have expected count less than 5. The minimum expected count is ,43.
b. Computed only for a 2x2 table

Q34: Comments taken into account during the performance monitoring

Crosstab

			qmNEW17_MSD		Total
			1	2	
q34_PYSOC	1	Count	17	1	18
		% within q34_PYSOC	94,4%	5,6%	100,0%
		% within qmNEW17_MSD	100,0%	25,0%	85,7%
		% of Total	81,0%	4,8%	85,7%
	2	Count	0	3	3
		% within q34_PYSOC	0,0%	100,0%	100,0%
		% within qmNEW17_MSD	0,0%	75,0%	14,3%
		% of Total	0,0%	14,3%	14,3%
Total		Count	17	4	21
		% within q34_PYSOC	81,0%	19,0%	100,0%
		% within qmNEW17_MSD	100,0%	100,0%	100,0%
		% of Total	81,0%	19,0%	100,0%

qmNEW17: Symptoms the last 12 months in the shoulders (any symptom)

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	14,875[a]	1	,000		
Continuity Correction[b]	9,381	1	,002		
Likelihood Ratio	12,726	1	,000		
Fisher's Exact Test				,003	,003
Linear-by-Linear Association	14,167	1	,000		
N of Valid Cases	21				

a. 3 cells (75,0%) have expected count less than 5. The minimum expected count is ,57.
b. Computed only for a 2x2 table

10.6.15 Logistic Regression tables for the MSD questionnaire (Manufacturing)

1. *DEPENDENT qmNEW17: Synptoms the last 12 months in the shoulders, _or qm17-18-19 (symptoms for shoulders) give the same results since they are the same*

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	q32_PYSOC	21,608	28420,719	,000	1	,999	2423211783,467	,000	.
	q45_PYSOC	20,052	8346,758	,000	1	,998	510901277,942	,000	.
	Constant	-82,169	37878,129	,000	1	,998	,000		

a. Variable(s) entered on step 1: q32_PYSOC, q45: Job stress.

No results

2. *DEPENDENT qm14 ή qm14-15-16: Symptoms the last 12 months in the neck*

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	q32_PYSOC	3,526	1,600	4,860	1	,027	34,000	1,479	781,787
	Constant	-6,360	2,395	7,052	1	,008	,002		

a. Variable(s) entered on step 1: q32: Consultation during performance monitoring.

10.6.16 Comparison between sectors

10.6.16.1 Comparison psychosocial questionnaire

Descriptives

AGEFINAL

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1	280	27,18	5,922	,354	26,49	27,88	20	49
2	42	34,21	7,247	1,118	31,96	36,47	22	55
Total	322	28,10	6,543	,365	27,38	28,82	20	55

ANOVA

AGEFINAL

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1806,038	1	1806,038	48,416	,000
Within Groups	11936,782	320	37,302		
Total	13742,820	321			

SEXFINAL * COMPANY2 Crosstabulation

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTURING	
SEXFINAL	1 MALE	Count	77	45	122
		% within SEXFINAL	63,1%	36,9%	100,0%
		% within COMPANY2	26,7%	93,8%	36,3%
		% of Total	22,9%	13,4%	36,3%
	2 FEMALE	Count	211	3	214
		% within SEXFINAL	98,6%	1,4%	100,0%
		% within COMPANY2	73,3%	6,2%	63,7%
		% of Total	62,8%	0,9%	63,7%
Total		Count	288	48	336
		% within SEXFINAL	85,7%	14,3%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	85,7%	14,3%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	79,897[a]	1	,000		
Continuity Correction[b]	77,025	1	,000		
Likelihood Ratio	83,401	1	,000		
Fisher's Exact Test				,000	,000
Linear-by-Linear Association	79,659	1	,000		
N of Valid Cases	336				

a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 17,43.
b. Computed only for a 2x2 table

Case Summaries

SECTOR		Q1_Q2 Quantitative demands	Q3_Q4 Learning demands	Q5_Q6 Positive challenges	Q7_Q8 Role Clarity	Q10_Q13 Control of decisions	Q11_Q12 Control of work pacing	Q18_Q19 Support from superior	Q20_Q21 Empowerment
1	N	114	115	114	113	113	115	114	106
	Mean	2,6798	1,9304	2,7807	4,4027	2,0044	2,9826	3,6623	2,1368
	Median	2,5000	2,0000	3,0000	5,0000	2,0000	3,0000	3,5000	2,0000
	Minimum	1,00	1,00	1,00	1,50	1,00	1,00	1,00	1,00
	Maximum	5,00	4,50	5,00	5,00	4,50	5,00	5,00	5,00
	Std. Deviation	1,08311	,91500	1,10316	,82877	,91976	,99765	,92290	1,08569
2	N	65	65	63	65	64	65	65	64
	Mean	2,8077	2,2769	3,8571	4,2000	2,9297	3,1538	4,1077	3,9531
	Median	2,5000	2,0000	4,0000	4,5000	3,0000	3,0000	4,0000	4,0000
	Minimum	1,50	1,00	1,00	2,00	1,00	1,00	1,00	1,00
	Maximum	5,00	3,50	5,00	5,00	4,50	5,00	5,00	5,00
	Std. Deviation	,78905	,64970	,90887	,84224	,84453	,98791	,89045	,95418
Total	N	179	180	177	178	177	180	179	170
	Mean	2,7263	2,0556	3,1638	4,3287	2,3390	3,0444	3,8240	2,8206
	Median	2,5000	2,0000	3,0000	4,5000	2,5000	3,0000	4,0000	3,0000
	Minimum	1,00	1,00	1,00	1,50	1,00	1,00	1,00	1,00
	Maximum	5,00	4,50	5,00	5,00	4,50	5,00	5,00	5,00
	Std. Deviation	,98610	,84379	1,15736	,83708	,99619	,99480	,93378	1,36043

Test Statistics[a]

	Q1_Q2	Q3_Q4	Q5_Q6	Q7_Q8	Q10_Q13	Q11_Q12	Q18_Q19	Q20_Q21
Mann-Whitney U	3487,000	2611,000	1659,000	3109,500	1658,500	3397,000	2560,500	819,000
Wilcoxon W	10042,000	9281,000	8214,000	5254,500	8099,500	10067,000	9115,500	6490,000
Z	-,663	-3,418	-5,966	-1,810	-6,065	-1,028	-3,486	-8,340
Asymp. Sig. (2-tailed)	,507	,001	,000	,070	,000	,304	,000	,000

a. Grouping Variable: COMPANY2

Case Summaries

SECTOR		Q23_Q24_Q25SSocial climate	Q26_Q27Group work	Q28_Q29 Innovative climate	Q43_Q44 Job satisfaction	Q17_Q18_Q19 Support from superior and co-workers	Q37_Q38 Inequality	Q39_Q40 Human recourse primacy
1	N	113	110	109	113	114	114	112
	Mean	3,1637	3,5909	3,0596	2,7124	3,8933	2,3947	2,4420
	Median	3,0000	3,5000	3,0000	2,5000	4,0000	2,0000	2,5000
	Minimum	1,33	1,00	1,00	1,00	1,00	1,00	1,00
	Maximum	5,00	5,00	5,00	4,50	5,00	5,00	5,00
	Std. Deviation	,60339	,88094	,93225	1,03252	,78679	1,16830	,90977
2	N	63	65	65	64	65	63	64
	Mean	2,9974	3,8923	3,9538	3,6094	4,1282	1,6429	3,2188
	Median	3,0000	4,0000	4,0000	3,5000	4,3333	1,0000	3,0000
	Minimum	1,50	1,50	1,50	1,50	1,00	1,00	1,00
	Maximum	5,00	5,00	5,00	5,00	5,00	5,00	5,00
	Std. Deviation	,73598	,69873	,82312	,72083	,75160	,93078	1,00347
Total	N	176	175	174	177	179	177	176
	Mean	3,1042	3,7029	3,3937	3,0367	3,9786	2,1271	2,7244
	Median	3,0000	4,0000	3,5000	3,0000	4,0000	2,0000	3,0000
	Minimum	1,33	1,00	1,00	1,00	1,00	1,00	1,00
	Maximum	5,00	5,00	5,00	5,00	5,00	5,00	5,00
	Std. Deviation	,65674	,82889	,99066	1,02528	,78034	1,14537	1,01386

Test Statistics[a]

	Q23_Q24_Q25	Q26_Q27	Q28_Q29	Q43_Q44	Q17_Q18_Q19	Q37_Q38	Q39_Q40
Mann-Whitney U	2951,500	2824,000	1650,000	1816,000	2933,500	2114,000	1985,500
Wilcoxon W	4967,500	8929,000	7645,000	8257,000	9488,500	4130,000	8313,500
Z	-1,903	-2,381	-5,963	-5,565	-2,338	-4,626	-4,970
Asymp. Sig. (2-tailed)	,057	,017	,000	,000	,019	,000	,000

a. Grouping Variable: COMPANY2

Case Summaries

SECTOR		q9_PYSOC	q14 Predict-ability	q15 Rumours about work	q16 Mastery of work	q17 Support from co-worker	q22 Support from friends/family	q30 Disturbing conflicts	q31_ Electronic per-formance con-trol	q36 Quantitative targets achievable
1	N	108	109	108	107	114	106	111	110	F98
	Mean	2,48	4,05	2,59	4,20	4,34	3,53	2,29	4,42	3,11
	Median	2,00	5,00	2,50	4,00	5,00	4,00	2,00	5,00	3,00
	Minimum	1	1	1	1	1	1	1	1	1
	Maximum	5	5	5	5	5	5	5	5	5
	Std. Deviation	1,357	1,350	1,223	,840	,840	1,494	1,147	,952	1,024
2	N	64	65	63	63	64	65	64	41	63
	Mean	2,48	2,91	2,79	3,87	4,17	3,63	2,00	3,20	3,32
	Median	2,00	3,00	3,00	4,00	4,00	4,00	2,00	3,00	3,00
	Minimum	1	1	1	2	1	1	1	1	1
	Maximum	5	5	5	5	5	5	4	5	5
	Std. Deviation	1,113	1,400	1,095	,660	,901	1,282	,909	1,123	1,013
Total	N	172	174	171	170	178	171	175	151	161
	Mean	2,48	3,62	2,67	4,08	4,28	3,57	2,18	4,09	3,19
	Median	2,00	4,00	3,00	4,00	4,00	4,00	2,00	5,00	3,00
	Minimum	1	1	1	1	1	1	1	1	1
	Maximum	5	5	5	5	5	5	5	5	5
	Std. Deviation	1,268	1,472	1,178	,792	,863	1,414	1,073	1,137	1,022

Test Statistics[a]

	q9_PYSOC	q14_PYSIC	q15_PYSOC	q16_PYSOC	q17_PYSOC	q22_PYSOC	q30_PYSOC	q31_PYSOC	q36_PYSOC
Mann-Whitney U	3353,500	1899,000	3060,000	2482,500	3238,500	3416,000	3120,000	907,000	2808,000
Wilcoxon W	9239,500	4044,000	8946,000	4498,500	5318,500	9087,000	5200,000	1768,000	7659,000
Z	-,334	-5,335	-1,132	-3,106	-1,357	-,095	-1,396	-6,098	-1,020
Asymp. Sig. (2-tailed)	,738	,000	,258	,002	,175	,924	,163	,000	,308

a. Grouping Variable: COMPANY2

10.6.16.2 Comparison MSD questionnaire

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTUR-ING	
qm14_MSD:	1 NO	Count	85	20	105
		% within qm14_MSD	81,0%	19,0%	100,0%
		% within COMPANY2	42,1%	87,0%	46,7%
		% of Total	37,8%	8,9%	46,7%
	2 YES	Count	117	3	120
		% within qm14_MSD	97,5%	2,5%	100,0%
		% within COMPANY2	57,9%	13,0%	53,3%
		% of Total	52,0%	1,3%	53,3%
Total		Count	202	23	225
		% within qm14_MSD	89,8%	10,2%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	89,8%	10,2%	100,0%

qm14_MSD: Symptoms the last 12 months in the neck

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	16,709[a]	1	,000		
Continuity Correction[b]	14,954	1	,000		
Likelihood Ratio	18,163	1	,000		
Fisher's Exact Test				,000	,000
Linear-by-Linear Association	16,635	1	,000		
N of Valid Cases	225				

a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 10,73.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTUR-ING	
qm15_MSD	1 NO	Count	122	7	129
		% within qm15_MSD	94,6%	5,4%	100,0%
		% within COMPANY2	73,5%	100,0%	74,6%
		% of Total	70,5%	4,0%	74,6%
	2 YES	Count	44	0	44
		% within qm15_MSD	100,0%	0,0%	100,0%
		% within COMPANY2	26,5%	0,0%	25,4%
		% of Total	25,4%	0,0%	25,4%
Total		Count	166	7	173
		% within qm15_MSD	96,0%	4,0%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	96,0%	4,0%	100,0%

qm15_MSD: Symptoms in the neck the last 12 months that prevented you from work

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2,488[a]	1	,115		
Continuity Correction[b]	1,287	1	,257		
Likelihood Ratio	4,208	1	,040		
Fisher's Exact Test				,193	,123
Linear-by-Linear Association	2,474	1	,116		
N of Valid Cases	173				

a. 1 cells (25,0%) have expected count less than 5. The minimum expected count is 1,78.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTUR-ING	
qm16_MSD	1 NO	Count	96	5	101
		% within qm16_MSD	95,0%	5,0%	100,0%
		% within COMPANY2	60,4%	100,0%	61,6%
		% of Total	58,5%	3,0%	61,6%
	2 YES	Count	63	0	63
		% within qm16_MSD	100,0%	0,0%	100,0%
		% within COMPANY2	39,6%	0,0%	38,4%
		% of Total	38,4%	0,0%	38,4%
Total		Count	159	5	164
		% within qm16_MSD	97,0%	3,0%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	97,0%	3,0%	100,0%

qm16_MSD: Symptoms in the neck the last 7 days

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3,217[a]	1	,073		
Continuity Correction[b]	1,760	1	,185		
Likelihood Ratio	4,945	1	,026		
Fisher's Exact Test				,157	,085
Linear-by-Linear Association	3,197	1	,074		
N of Valid Cases	164				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is 1,92.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTURING	
MSDqm14_15_16	1 NEVER PAIN	Count	85	20	105
		% within MSDqm14_15_16	81,0%	19,0%	100,0%
		% within COMPANY2	42,1%	87,0%	46,7%
		% of Total	37,8%	8,9%	46,7%
	2 AT SOME POINT OR PERIOD	Count	117	3	120
		% within MSDqm14_15_16	97,5%	2,5%	100,0%
		% within COMPANY2	57,9%	13,0%	53,3%
		% of Total	52,0%	1,3%	53,3%
Total		Count	202	23	225
		% within MSDqm14_15_16	89,8%	10,2%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	89,8%	10,2%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	16,709[a]	1	,000		
Continuity Correction[b]	14,954	1	,000		
Likelihood Ratio	18,163	1	,000		
Fisher's Exact Test				,000	,000
Linear-by-Linear Association	16,635	1	,000		
N of Valid Cases	225				

a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 10,73.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTURING	
qm17_MSD	1 NO	Count	92	19	111
		% within qm17_MSD	82,9%	17,1%	100,0%
		% within COMPANY2	49,2%	79,2%	52,6%
		% of Total	43,6%	9,0%	52,6%
	2 Yes, in the right shoulders	Count	32	2	34
		% within qm17_MSD	94,1%	5,9%	100,0%
		% within COMPANY2	17,1%	8,3%	16,1%
		% of Total	15,2%	0,9%	16,1%
	3 Yes, in the left shoulders	Count	10	2	12
		% within qm17_MSD	83,3%	16,7%	100,0%
		% within COMPANY2	5,3%	8,3%	5,7%
		% of Total	4,7%	0,9%	5,7%
	4 Yes, in both shoulders	Count	53	1	54
		% within qm17_MSD	98,1%	1,9%	100,0%
		% within COMPANY2	28,3%	4,2%	25,6%
		% of Total	25,1%	0,5%	25,6%
Total		Count	187	24	211
		% within qm17_MSD	88,6%	11,4%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	88,6%	11,4%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9,840[a]	3	,020
Likelihood Ratio	11,899	3	,008
Linear-by-Linear Association	7,486	1	,006
N of Valid Cases	211		

a. 2 cells (25,0%) have expected count less than 5. The minimum expected count is 1,36.

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTURING	
qmNEW17_MSD	1 όχι	Count	101	20	121
		% within qmNEW17_MSD	83,5%	16,5%	100,0%
		% within COMPANY2	50,8%	80,0%	54,0%
		% of Total	45,1%	8,9%	54,0%
	2 ναι	Count	98	5	103
		% within qmNEW17_MSD	95,1%	4,9%	100,0%
		% within COMPANY2	49,2%	20,0%	46,0%
		% of Total	43,8%	2,2%	46,0%
Total		Count	199	25	224
		% within qmNEW17_MSD	88,8%	11,2%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	88,8%	11,2%	100,0%

qmNEW17_MSD: Symptoms in the shoulders the last 12 months (any symptom)

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	7,648[a]	1	,006		
Continuity Correction[b]	6,516	1	,011		
Likelihood Ratio	8,234	1	,004		
Fisher's Exact Test				,006	,004
Linear-by-Linear Association	7,614	1	,006		
N of Valid Cases	224				

a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 11,50.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTUR-ING	
qm18_MSD	1 NO	Count	113	5	118
		% within qm18_MSD	95,8%	4,2%	100,0%
		% within COMPANY2	76,4%	100,0%	77,1%
		% of Total	73,9%	3,3%	77,1%
	2 YES	Count	35	0	35
		% within qm18_MSD	100,0%	0,0%	100,0%
		% within COMPANY2	23,6%	0,0%	22,9%
		% of Total	22,9%	0,0%	22,9%
Total		Count	148	5	153
		% within qm18_MSD	96,7%	3,3%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	96,7%	3,3%	100,0%

qm18: Symptoms in the shoulders the last 12 months that prevented you from work

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1,533[a]	1	,216		
Continuity Correction[b]	,486	1	,486		
Likelihood Ratio	2,647	1	,104		
Fisher's Exact Test				,589	,268
Linear-by-Linear Association	1,523	1	,217		
N of Valid Cases	153				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is 1,14.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTUR-ING	
qm19_MSD	1 όχι	Count	85	5	90
		% within qm19_MSD	94,4%	5,6%	100,0%
		% within COMPANY2	60,3%	100,0%	61,6%
		% of Total	58,2%	3,4%	61,6%
	2 ναι	Count	56	0	56
		% within qm19_MSD	100,0%	0,0%	100,0%
		% within COMPANY2	39,7%	0,0%	38,4%
		% of Total	38,4%	0,0%	38,4%
Total		Count	141	5	146
		% within qm19_MSD	96,6%	3,4%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	96,6%	3,4%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3,221[a]	1	,073		
Continuity Correction[b]	1,761	1	,185		
Likelihood Ratio	4,948	1	,026		
Fisher's Exact Test				,157	,085
Linear-by-Linear Association	3,199	1	,074		
N of Valid Cases	146				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is 1,92.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CEN-TERS	2 MANUFAC-TURING	
MSDqm17_18_19	1 NEVER PAIN	Count	101	20	121
		% within MSDqm17_18_19	83,5%	16,5%	100,0%
		% within COMPANY2	50,8%	80,0%	54,0%
		% of Total	45,1%	8,9%	54,0%
	2 AT SOME POINT OR PERIOD	Count	98	5	103
		% within MSDqm17_18_19	95,1%	4,9%	100,0%
		% within COMPANY2	49,2%	20,0%	46,0%
		% of Total	43,8%	2,2%	46,0%
Total		Count	199	25	224
		% within MSDqm17_18_19	88,8%	11,2%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	88,8%	11,2%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	7,648[a]	1	,006		
Continuity Correction[b]	6,516	1	,011		
Likelihood Ratio	8,234	1	,004		
Fisher's Exact Test				,006	,004
Linear-by-Linear Association	7,614	1	,006		
N of Valid Cases	224				

a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 11,50.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTURING	
qm20_MSD	1 No	Count	160	20	180
		% within qm20_MSD	88,9%	11,1%	100,0%
		% within COMPANY2	87,0%	87,0%	87,0%
		% of Total	77,3%	9,7%	87,0%
	2 Yes, in the right elbow	Count	15	3	18
		% within qm20_MSD	83,3%	16,7%	100,0%
		% within COMPANY2	8,2%	13,0%	8,7%
		% of Total	7,2%	1,4%	8,7%
	3 Yes, in the left elbow	Count	4	0	4
		% within qm20_MSD	100,0%	0,0%	100,0%
		% within COMPANY2	2,2%	0,0%	1,9%
		% of Total	1,9%	0,0%	1,9%
	4 Yes, in both elbows	Count	5	0	5
		% within qm20_MSD	100,0%	0,0%	100,0%
		% within COMPANY2	2,7%	0,0%	2,4%
		% of Total	2,4%	0,0%	2,4%
Total		Count	184	23	207
		% within qm20_MSD	88,9%	11,1%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	88,9%	11,1%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1,688[a]	3	,640
Likelihood Ratio	2,617	3	,455
Linear-by-Linear Association	,344	1	,558
N of Valid Cases	207		

a. 5 cells (62,5%) have expected count less than 5. The minimum expected count is ,44.

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTURING	
qmNEW20_MSD	1 NO	Count	171	20	191
		% within qmNEW20_MSD	89,5%	10,5%	100,0%
		% within COMPANY2	87,7%	87,0%	87,6%
		% of Total	78,4%	9,2%	87,6%
	2 YES	Count	24	3	27
		% within qmNEW20_MSD	88,9%	11,1%	100,0%
		% within COMPANY2	12,3%	13,0%	12,4%
		% of Total	11,0%	1,4%	12,4%
Total		Count	195	23	218
		% within qmNEW20_MSD	89,4%	10,6%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	89,4%	10,6%	100,0%

qmNEW20_MSD:

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,010[a]	1	,919		
Continuity Correction[b]	,000	1	1,000		
Likelihood Ratio	,010	1	,920		
Fisher's Exact Test				1,000	,566
Linear-by-Linear Association	,010	1	,919		
N of Valid Cases	218				

a. 1 cells (25,0%) have expected count less than 5. The minimum expected count is 2,85.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTURING	
qm21_MSD	1 NO	Count	105	6	111
		% within qm21_MSD	94,6%	5,4%	100,0%
		% within COMPANY2	91,3%	100,0%	91,7%
		% of Total	86,8%	5,0%	91,7%
	2 YES	Count	10	0	10
		% within qm21_MSD	100,0%	0,0%	100,0%
		% within COMPANY2	8,7%	0,0%	8,3%
		% of Total	8,3%	0,0%	8,3%
Total		Count	115	6	121
		% within qm21_MSD	95,0%	5,0%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	95,0%	5,0%	100,0%

qm21_MSD:

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,569[a]	1	,451		
Continuity Correction[b]	,000	1	1,000		
Likelihood Ratio	1,063	1	,303		
Fisher's Exact Test				1,000	,589
Linear-by-Linear Association	,564	1	,453		
N of Valid Cases	121				

a. 1 cells (25,0%) have expected count less than 5. The minimum expected count is ,50.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTURING	
qm22_MSD	1 no	Count	101	5	106
		% within qm22_MSD	95,3%	4,7%	100,0%
		% within COMPANY2	89,4%	100,0%	89,8%
		% of Total	85,6%	4,2%	89,8%
	2 yes	Count	12	0	12
		% within qm22_MSD	100,0%	0,0%	100,0%
		% within COMPANY2	10,6%	0,0%	10,2%
		% of Total	10,2%	0,0%	10,2%
Total		Count	113	5	118
		% within qm22_MSD	95,8%	4,2%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	95,8%	4,2%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,591[a]	1	,442		
Continuity Correction[b]	,000	1	,990		
Likelihood Ratio	1,097	1	,295		
Fisher's Exact Test				1,000	,579
Linear-by-Linear Association	,586	1	,444		
N of Valid Cases	118				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is ,51.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTURING	
MSDqm20_21_22	1 NEVER PAIN	Count	171	20	191
		% within MSDqm20_21_22	89,5%	10,5%	100,0%
		% within COMPANY2	87,7%	87,0%	87,6%
		% of Total	78,4%	9,2%	87,6%
	2 AT SOME POINT OR PERIOD	Count	24	3	27
		% within MSDqm20_21_22	88,9%	11,1%	100,0%
		% within COMPANY2	12,3%	13,0%	12,4%
		% of Total	11,0%	1,4%	12,4%
Total		Count	195	23	218
		% within MSDqm20_21_22	89,4%	10,6%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	89,4%	10,6%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,010[a]	1	,919		
Continuity Correction[b]	,000	1	1,000		
Likelihood Ratio	,010	1	,920		
Fisher's Exact Test				1,000	,566
Linear-by-Linear Association	,010	1	,919		
N of Valid Cases	218				

a. 1 cells (25,0%) have expected count less than 5. The minimum expected count is 2,85.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTURING	
qm23_MSD	1 No	Count	102	18	120
		% within qm23_MSD	85,0%	15,0%	100,0%
		% within COMPANY2	53,4%	81,8%	56,3%
		% of Total	47,9%	8,5%	56,3%
	2 Yes, in the right wrist /hand	Count	60	3	63
		% within qm23_MSD	95,2%	4,8%	100,0%
		% within COMPANY2	31,4%	13,6%	29,6%
		% of Total	28,2%	1,4%	29,6%
	3 Yes, in the left wrist/ hand	Count	5	1	6
		% within qm23_MSD	83,3%	16,7%	100,0%
		% within COMPANY2	2,6%	4,5%	2,8%
		% of Total	2,3%	0,5%	2,8%
	4 Yes, in both wrist /hand	Count	24	0	24
		% within qm23_MSD	100,0%	0,0%	100,0%
		% within COMPANY2	12,6%	0,0%	11,3%
		% of Total	11,3%	0,0%	11,3%
Total		Count	191	22	213
		% within qm23_MSD	89,7%	10,3%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	89,7%	10,3%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7,960[a]	3	,047
Likelihood Ratio	10,557	3	,014
Linear-by-Linear Association	5,529	1	,019
N of Valid Cases	213		

a. 2 cells (25,0%) have expected count less than 5. The minimum expected count is ,62.

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTURING	
qmNEW23_MSD	1 NO	Count	108	18	126
		% within qmNEW23_MSD	85,7%	14,3%	100,0%
		% within COMPANY2	54,3%	81,8%	57,0%
		% of Total	48,9%	8,1%	57,0%
	2 YES	Count	91	4	95
		% within qmNEW23_MSD	95,8%	4,2%	100,0%
		% within COMPANY2	45,7%	18,2%	43,0%
		% of Total	41,2%	1,8%	43,0%
Total		Count	199	22	221
		% within qmNEW23_MSD	90,0%	10,0%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	90,0%	10,0%	100,0%

qmNEW23_MSD: Symptoms the last 12 months in the wrists/hands (any symptom)

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	6,134[a]	1	,013		
Continuity Correction[b]	5,061	1	,024		
Likelihood Ratio	6,728	1	,009		
Fisher's Exact Test				,013	,010
Linear-by-Linear Association	6,106	1	,013		
N of Valid Cases	221				

a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 9,46.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTUR-ING	
qm24_MSD	1 NO	Count	97	7	104
		% within qm24_MSD	93,3%	6,7%	100,0%
		% within COMPANY2	68,3%	100,0%	69,8%
		% of Total	65,1%	4,7%	69,8%
	2 YES	Count	45	0	45
		% within qm24_MSD	100,0%	0,0%	100,0%
		% within COMPANY2	31,7%	0,0%	30,2%
		% of Total	30,2%	0,0%	30,2%
Total		Count	142	7	149
		% within qm24_MSD	95,3%	4,7%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	95,3%	4,7%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3,178[a]	1	,075		
Continuity Correction[b]	1,853	1	,173		
Likelihood Ratio	5,182	1	,023		
Fisher's Exact Test				,102	,076
Linear-by-Linear Association	3,157	1	,076		
N of Valid Cases	149				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is 2,11.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTURING	
qm25_MSD	1 όχι	Count	87	6	93
		% within qm25_MSD	93,5%	6,5%	100,0%
		% within COMPANY2	61,7%	100,0%	63,3%
		% of Total	59,2%	4,1%	63,3%
	2 ναι	Count	54	0	54
		% within qm25_MSD	100,0%	0,0%	100,0%
		% within COMPANY2	38,3%	0,0%	36,7%
		% of Total	36,7%	0,0%	36,7%
Total		Count	141	6	147
		% within qm25_MSD	95,9%	4,1%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	95,9%	4,1%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3,632[a]	1	,057		
Continuity Correction[b]	2,171	1	,141		
Likelihood Ratio	5,641	1	,018		
Fisher's Exact Test				,086	,060
Linear-by-Linear Association	3,607	1	,058		
N of Valid Cases	147				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is 2,20.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTURING	
MSDqm23_24_25	1 NEVER PAIN	Count	108	18	126
		% within MSDqm23_24_25	85,7%	14,3%	100,0%
		% within COMPANY2	54,3%	81,8%	57,0%
		% of Total	48,9%	8,1%	57,0%
	2 AT SOME TIME OR PERIOD	Count	91	4	95
		% within MSDqm23_24_25	95,8%	4,2%	100,0%
		% within COMPANY2	45,7%	18,2%	43,0%
		% of Total	41,2%	1,8%	43,0%
Total		Count	199	22	221
		% within MSDqm23_24_25	90,0%	10,0%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	90,0%	10,0%	100,0%

MSDqm23_24_25 Any symptom wrist/hand

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	6,134[a]	1	,013		
Continuity Correction[b]	5,061	1	,024		
Likelihood Ratio	6,728	1	,009		
Fisher's Exact Test				,013	,010
Linear-by-Linear Association	6,106	1	,013		
N of Valid Cases	221				

a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 9,46.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTUR-ING	
qm26_MSD	1 NO	Count	151	22	173
		% within qm26_MSD	87,3%	12,7%	100,0%
		% within COMPANY2	77,0%	95,7%	79,0%
		% of Total	68,9%	10,0%	79,0%
	2 YES	Count	45	1	46
		% within qm26_MSD	97,8%	2,2%	100,0%
		% within COMPANY2	23,0%	4,3%	21,0%
		% of Total	20,5%	0,5%	21,0%
Total		Count	196	23	219
		% within qm26_MSD	89,5%	10,5%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	89,5%	10,5%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4,297[a]	1	,038		
Continuity Correction[b]	3,249	1	,071		
Likelihood Ratio	5,710	1	,017		
Fisher's Exact Test				,054	,025
Linear-by-Linear Association	4,278	1	,039		
N of Valid Cases	219				

a. 1 cells (25,0%) have expected count less than 5. The minimum expected count is 4,83.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTUR-ING	
qm27_MSD	1 NO	Count	106	4	110
		% within qm27_MSD	96,4%	3,6%	100,0%
		% within COMPANY2	87,6%	100,0%	88,0%
		% of Total	84,8%	3,2%	88,0%
	2 YES	Count	15	0	15
		% within qm27_MSD	100,0%	0,0%	100,0%
		% within COMPANY2	12,4%	0,0%	12,0%
		% of Total	12,0%	0,0%	12,0%
Total		Count	121	4	125
		% within qm27_MSD	96,8%	3,2%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	96,8%	3,2%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,563[a]	1	,453		
Continuity Correction[b]	,000	1	1,000		
Likelihood Ratio	1,041	1	,308		
Fisher's Exact Test				1,000	,596
Linear-by-Linear Association	,559	1	,455		
N of Valid Cases	125				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is ,48.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTUR-ING	
qm28_MSD	1 NO	Count	95	3	98
		% within qm28_MSD	96,9%	3,1%	100,0%
		% within COMPANY2	79,8%	100,0%	80,3%
		% of Total	77,9%	2,5%	80,3%
	2 YES	Count	24	0	24
		% within qm28_MSD	100,0%	0,0%	100,0%
		% within COMPANY2	20,2%	0,0%	19,7%
		% of Total	19,7%	0,0%	19,7%
Total		Count	119	3	122
		% within qm28_MSD	97,5%	2,5%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	97,5%	2,5%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,753[a]	1	,385		
Continuity Correction[b]	,018	1	,895		
Likelihood Ratio	1,333	1	,248		
Fisher's Exact Test				1,000	,515
Linear-by-Linear Association	,747	1	,387		
N of Valid Cases	122				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is ,59.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTURING	
MSDqm26_27_28	1 NEVER PAIN	Count	151	22	173
		% within MSDqm26_27_28	87,3%	12,7%	100,0%
		% within COMPANY2	77,0%	95,7%	79,0%
		% of Total	68,9%	10,0%	79,0%
	2 AT SOME POINT OR PERIOD	Count	45	1	46
		% within MSDqm26_27_28	97,8%	2,2%	100,0%
		% within COMPANY2	23,0%	4,3%	21,0%
		% of Total	20,5%	0,5%	21,0%
Total		Count	196	23	219
		% within MSDqm26_27_28	89,5%	10,5%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	89,5%	10,5%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4,297[a]	1	,038		
Continuity Correction[b]	3,249	1	,071		
Likelihood Ratio	5,710	1	,017		
Fisher's Exact Test				,054	,025
Linear-by-Linear Association	4,278	1	,039		
N of Valid Cases	219				

a. 1 cells (25,0%) have expected count less than 5. The minimum expected count is 4,83.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTUR-ING	
qm29_MSD	1 NO	Count	131	20	151
		% within qm29_MSD	86,8%	13,2%	100,0%
		% within COMPANY2	66,2%	87,0%	68,3%
		% of Total	59,3%	9,0%	68,3%
	2 YES	Count	67	3	70
		% within qm29_MSD	95,7%	4,3%	100,0%
		% within COMPANY2	33,8%	13,0%	31,7%
		% of Total	30,3%	1,4%	31,7%
Total		Count	198	23	221
		% within qm29_MSD	89,6%	10,4%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	89,6%	10,4%	100,0%

qm29_MSD: Symptoms the last 12 months lower back

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4,117[a]	1	,042		
Continuity Correction[b]	3,213	1	,073		
Likelihood Ratio	4,745	1	,029		
Fisher's Exact Test				,056	,031
Linear-by-Linear Association	4,099	1	,043		
N of Valid Cases	221				

a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 7,29.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTUR-ING	
qm30_MSD	1 NO	Count	99	4	103
		% within qm30_MSD	96,1%	3,9%	100,0%
		% within COMPANY2	75,0%	80,0%	75,2%
		% of Total	72,3%	2,9%	75,2%
	2 YES	Count	33	1	34
		% within qm30_MSD	97,1%	2,9%	100,0%
		% within COMPANY2	25,0%	20,0%	24,8%
		% of Total	24,1%	0,7%	24,8%
Total		Count	132	5	137
		% within qm30_MSD	96,4%	3,6%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	96,4%	3,6%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,065[a]	1	,799		
Continuity Correction[b]	,000	1	1,000		
Likelihood Ratio	,068	1	,795		
Fisher's Exact Test				1,000	,637
Linear-by-Linear Association	,064	1	,800		
N of Valid Cases	137				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is 1,24.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTURING	
qm31_MSD	1 NO	Count	91	4	95
		% within qm31_MSD	95,8%	4,2%	100,0%
		% within COMPANY2	70,0%	100,0%	70,9%
		% of Total	67,9%	3,0%	70,9%
	2 YES	Count	39	0	39
		% within qm31_MSD	100,0%	0,0%	100,0%
		% within COMPANY2	30,0%	0,0%	29,1%
		% of Total	29,1%	0,0%	29,1%
Total		Count	130	4	134
		% within qm31_MSD	97,0%	3,0%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	97,0%	3,0%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1,693[a]	1	,193		
Continuity Correction[b]	,551	1	,458		
Likelihood Ratio	2,802	1	,094		
Fisher's Exact Test				,322	,248
Linear-by-Linear Association	1,680	1	,195		
N of Valid Cases	134				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is 1,16.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTURING	
MSDqm29_30_31	1 NEVER PAIN	Count	131	20	151
		% within MSDqm29_30_31	86,8%	13,2%	100,0%
		% within COMPANY2	66,2%	87,0%	68,3%
		% of Total	59,3%	9,0%	68,3%
	2 AT SOME POINT OR PERIOD	Count	67	3	70
		% within MSDqm29_30_31	95,7%	4,3%	100,0%
		% within COMPANY2	33,8%	13,0%	31,7%
		% of Total	30,3%	1,4%	31,7%
Total		Count	198	23	221
		% within MSDqm29_30_31	89,6%	10,4%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	89,6%	10,4%	100,0%

MSDqm29_30_31: Combination symptoms in lower back

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4,117[a]	1	,042		
Continuity Correction[b]	3,213	1	,073		
Likelihood Ratio	4,745	1	,029		
Fisher's Exact Test				,056	,031
Linear-by-Linear Association	4,099	1	,043		
N of Valid Cases	221				

a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 7,29.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTURING	
qm32_MSD	1 NO	Count	169	18	187
		% within qm32_MSD	90,4%	9,6%	100,0%
		% within COMPANY2	85,8%	78,3%	85,0%
		% of Total	76,8%	8,2%	85,0%
	2 YES	Count	28	5	33
		% within qm32_MSD	84,8%	15,2%	100,0%
		% within COMPANY2	14,2%	21,7%	15,0%
		% of Total	12,7%	2,3%	15,0%
Total		Count	197	23	220
		% within qm32_MSD	89,5%	10,5%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	89,5%	10,5%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)

Pearson Chi-Square	,915[a]	1	,339		
Continuity Correction[b]	,420	1	,517		
Likelihood Ratio	,834	1	,361		
Fisher's Exact Test				,355	,248
Linear-by-Linear Association	,911	1	,340		
N of Valid Cases	220				

a. 1 cells (25,0%) have expected count less than 5. The minimum expected count is 3,45.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTUR-ING	
qm33_MSD	1 NO	Count	105	7	112
		% within qm33_MSD	93,8%	6,2%	100,0%
		% within COMPANY2	90,5%	87,5%	90,3%
		% of Total	84,7%	5,6%	90,3%
	2 YES	Count	11	1	12
		% within qm33_MSD	91,7%	8,3%	100,0%
		% within COMPANY2	9,5%	12,5%	9,7%
		% of Total	8,9%	0,8%	9,7%
Total		Count	116	8	124
		% within qm33_MSD	93,5%	6,5%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	93,5%	6,5%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,078[a]	1	,780		
Continuity Correction[b]	,000	1	1,000		
Likelihood Ratio	,072	1	,788		
Fisher's Exact Test				,568	,568
Linear-by-Linear Association	,077	1	,781		
N of Valid Cases	124				

a. 1 cells (25,0%) have expected count less than 5. The minimum expected count is ,77.
b. Computed only for a 2x2 table

Crosstab

	COMPANY2	Total

			1 CALL CENTERS	2 MANUFACTUR-ING	
qm34_MSD	1 NO	Count	103	7	110
		% within qm34_MSD	93,6%	6,4%	100,0%
		% within COMPANY2	90,4%	100,0%	90,9%
		% of Total	85,1%	5,8%	90,9%
	2 YES	Count	11	0	11
		% within qm34_MSD	100,0%	0,0%	100,0%
		% within COMPANY2	9,6%	0,0%	9,1%
		% of Total	9,1%	0,0%	9,1%
Total		Count	114	7	121
		% within qm34_MSD	94,2%	5,8%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	94,2%	5,8%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,743[a]	1	,389		
Continuity Correction[b]	,034	1	,853		
Likelihood Ratio	1,377	1	,241		
Fisher's Exact Test				1,000	,504
Linear-by-Linear Association	,737	1	,391		
N of Valid Cases	121				

a. 1 cells (25,0%) have expected count less than 5. The minimum expected count is ,64.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CEN-TERS	2 MANUFAC-TURING	
MSDqm32_33_34	1 NEVER PAIN	Count	169	18	187
		% within MSDqm32_33_34	90,4%	9,6%	100,0%
		% within COMPANY2	85,8%	78,3%	85,0%
		% of Total	76,8%	8,2%	85,0%
	2 AT SOME POINT PR PERIOD	Count	28	5	33
		% within MSDqm32_33_34	84,8%	15,2%	100,0%
		% within COMPANY2	14,2%	21,7%	15,0%
		% of Total	12,7%	2,3%	15,0%
Total		Count	197	23	220
		% within MSDqm32_33_34	89,5%	10,5%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	89,5%	10,5%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,915[a]	1	,339		
Continuity Correction[b]	,420	1	,517		
Likelihood Ratio	,834	1	,361		
Fisher's Exact Test				,355	,248
Linear-by-Linear Association	,911	1	,340		
N of Valid Cases	220				

a. 1 cells (25,0%) have expected count less than 5. The minimum expected count is 3,45.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTUR-ING	
qm35_MSD	1 NO	Count	145	22	167
		% within qm35_MSD	86,8%	13,2%	100,0%
		% within COMPANY2	74,4%	91,7%	76,3%
		% of Total	66,2%	10,0%	76,3%
	2 YES	Count	50	2	52
		% within qm35_MSD	96,2%	3,8%	100,0%
		% within COMPANY2	25,6%	8,3%	23,7%
		% of Total	22,8%	0,9%	23,7%
Total		Count	195	24	219
		% within qm35_MSD	89,0%	11,0%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	89,0%	11,0%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3,535[a]	1	,060		
Continuity Correction[b]	2,644	1	,104		
Likelihood Ratio	4,291	1	,038		
Fisher's Exact Test				,075	,044
Linear-by-Linear Association	3,519	1	,061		
N of Valid Cases	219				

a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 5,70.
b. Computed only for a 2x2 table

Crosstab

	COMPANY2	Total

			1 CALL CENTERS	2 MANUFACTUR-ING	
qm36_MSD	1 NO	Count	103	4	107
		% within qm36_MSD	96,3%	3,7%	100,0%
		% within COMPANY2	84,4%	100,0%	84,9%
		% of Total	81,7%	3,2%	84,9%
	2 YES	Count	19	0	19
		% within qm36_MSD	100,0%	0,0%	100,0%
		% within COMPANY2	15,6%	0,0%	15,1%
		% of Total	15,1%	0,0%	15,1%
Total		Count	122	4	126
		% within qm36_MSD	96,8%	3,2%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	96,8%	3,2%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,734[a]	1	,392		
Continuity Correction[b]	,021	1	,884		
Likelihood Ratio	1,331	1	,249		
Fisher's Exact Test				1,000	,516
Linear-by-Linear Association	,728	1	,394		
N of Valid Cases	126				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is ,60.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTUR-ING	
qm37_MSD	1 NO	Count	103	3	106
		% within qm37_MSD	97,2%	2,8%	100,0%
		% within COMPANY2	84,4%	100,0%	84,8%
		% of Total	82,4%	2,4%	84,8%
	2 YES	Count	19	0	19
		% within qm37_MSD	100,0%	0,0%	100,0%
		% within COMPANY2	15,6%	0,0%	15,2%
		% of Total	15,2%	0,0%	15,2%
Total		Count	122	3	125
		% within qm37_MSD	97,6%	2,4%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	97,6%	2,4%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,551[a]	1	,458		
Continuity Correction[b]	,000	1	1,000		
Likelihood Ratio	1,002	1	,317		
Fisher's Exact Test				1,000	,607
Linear-by-Linear Association	,547	1	,460		
N of Valid Cases	125				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is ,46.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTURING	
MSDqm35_36_37	1 NEVER PAIN	Count	145	22	167
		% within MSDqm35_36_37	86,8%	13,2%	100,0%
		% within COMPANY2	74,4%	91,7%	76,3%
		% of Total	66,2%	10,0%	76,3%
	2 AT SOME POINT OR PERIOD	Count	50	2	52
		% within MSDqm35_36_37	96,2%	3,8%	100,0%
		% within COMPANY2	25,6%	8,3%	23,7%
		% of Total	22,8%	0,9%	23,7%
Total		Count	195	24	219
		% within MSDqm35_36_37	89,0%	11,0%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	89,0%	11,0%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3,535[a]	1	,060		
Continuity Correction[b]	2,644	1	,104		
Likelihood Ratio	4,291	1	,038		
Fisher's Exact Test				,075	,044
Linear-by-Linear Association	3,519	1	,061		
N of Valid Cases	219				

a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 5,70.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTUR-ING	
qm38_MSD	1 NO	Count	175	19	194
		% within qm38_MSD	90,2%	9,8%	100,0%
		% within COMPANY2	88,8%	86,4%	88,6%
		% of Total	79,9%	8,7%	88,6%
	2 YES	Count	22	3	25
		% within qm38_MSD	88,0%	12,0%	100,0%
		% within COMPANY2	11,2%	13,6%	11,4%
		% of Total	10,0%	1,4%	11,4%
Total		Count	197	22	219
		% within qm38_MSD	90,0%	10,0%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	90,0%	10,0%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,119[a]	1	,730		
Continuity Correction[b]	,000	1	1,000		
Likelihood Ratio	,114	1	,736		
Fisher's Exact Test				,724	,473
Linear-by-Linear Association	,119	1	,730		
N of Valid Cases	219				

a. 1 cells (25,0%) have expected count less than 5. The minimum expected count is 2,51.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTUR-ING	
qm39_MSD	1 NO	Count	108	5	113
		% within qm39_MSD	95,6%	4,4%	100,0%
		% within COMPANY2	95,6%	100,0%	95,8%
		% of Total	91,5%	4,2%	95,8%
	2 YES	Count	5	0	5
		% within qm39_MSD	100,0%	0,0%	100,0%
		% within COMPANY2	4,4%	0,0%	4,2%
		% of Total	4,2%	0,0%	4,2%
Total		Count	113	5	118
		% within qm39_MSD	95,8%	4,2%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	95,8%	4,2%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,231[a]	1	,631		
Continuity Correction[b]	,000	1	1,000		
Likelihood Ratio	,443	1	,506		
Fisher's Exact Test				1,000	,802
Linear-by-Linear Association	,229	1	,632		
N of Valid Cases	118				

a. 3 cells (75,0%) have expected count less than 5. The minimum expected count is ,21.
b. Computed only for a 2x2 table

Crosstab

			COMPANY2		Total
			1 CALL CENTERS	2 MANUFACTUR-ING	
qm40_MSD	1 NO	Count	100	4	104
		% within qm40_MSD	96,2%	3,8%	100,0%
		% within COMPANY2	87,7%	100,0%	88,1%
		% of Total	84,7%	3,4%	88,1%
	2 YES	Count	14	0	14
		% within qm40_MSD	100,0%	0,0%	100,0%
		% within COMPANY2	12,3%	0,0%	11,9%
		% of Total	11,9%	0,0%	11,9%
Total		Count	114	4	118
		% within qm40_MSD	96,6%	3,4%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	96,6%	3,4%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,557[a]	1	,455		
Continuity Correction[b]	,000	1	1,000		
Likelihood Ratio	1,029	1	,310		
Fisher's Exact Test				1,000	,599
Linear-by-Linear Association	,553	1	,457		
N of Valid Cases	118				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is ,47.
b. Computed only for a 2x2 table

Crosstab

	COMPANY2	Total

			1 CALL CENTERS	2 MANUFACTURING	
MSDqm38_39_40	1 NEVER PAIN	Count	175	19	194
		% within MSDqm38_39_40	90,2%	9,8%	100,0%
		% within COMPANY2	88,8%	86,4%	88,6%
		% of Total	79,9%	8,7%	88,6%
	2 AT SOME POINT OR PERIOD	Count	22	3	25
		% within MSDqm38_39_40	88,0%	12,0%	100,0%
		% within COMPANY2	11,2%	13,6%	11,4%
		% of Total	10,0%	1,4%	11,4%
Total		Count	197	22	219
		% within MSDqm38_39_40	90,0%	10,0%	100,0%
		% within COMPANY2	100,0%	100,0%	100,0%
		% of Total	90,0%	10,0%	100,0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	,119[a]	1	,730		
Continuity Correction[b]	,000	1	1,000		
Likelihood Ratio	,114	1	,736		
Fisher's Exact Test				,724	,473
Linear-by-Linear Association	,119	1	,730		
N of Valid Cases	219				

a. 1 cells (25,0%) have expected count less than 5. The minimum expected count is 2,51.
b. Computed only for a 2x2 table

Correlations

			Leanness	Q1_Q2	Q3_Q4	Q5_Q6	Q7_Q8	Q10_Q13	Q11_Q12	Q18_Q19	Q20_Q21	Q23_Q24_Q25	Q26_Q27	Q28_Q29	Q43_Q44	Q17_Q18_Q19
Spearman's rho	Leanness	Correlation Coefficient	1,000	,248**	-,016	,093	-,005	,259**	,250**	-,073	,048	,223**	,078	,013	,086	-,054
		Sig. (2-tailed)	.	,001	,827	,220	,950	,001	,001	,330	,532	,003	,306	,863	,258	,472
		N	353	179	180	177	178	177	180	179	170	176	175	174	177	179
	Q1_Q2	Correlation Coefficient	,248**	1,000	,242**	,031	-,015	,165*	,121	-,006	,043	,059	,029	-,061	-,042	-,036
		Sig. (2-tailed)	,001	.	,001	,681	,841	,029	,106	,935	,580	,442	,710	,423	,578	,635
		N	179	179	178	175	176	176	178	177	169	174	173	174	175	177
	Q3_Q4	Correlation Coefficient	-,016	,242**	1,000	,148*	-,271**	,204**	-,053	,016	,236**	-,155*	-,080	,025	,080	-,041
		Sig. (2-tailed)	,827	,001	.	,049	,000	,006	,477	,835	,002	,040	,294	,746	,289	,583
		N	180	178	180	177	178	177	180	179	170	176	175	174	177	179
	Q5_Q6	Correlation Coefficient	,093	,031	,148*	1,000	,079	,428**	,172*	,419**	,592**	-,085	,339**	,452**	,455**	,388**
		Sig. (2-tailed)	,220	,681	,049	.	,299	,000	,022	,000	,000	,264	,000	,000	,000	,000
		N	177	175	177	177	176	175	177	177	168	175	173	172	175	177
	Q7_Q8	Correlation Coefficient	-,005	-,015	-,271**	,079	1,000	-,226**	,056	,151*	,002	,328**	,324**	,199**	,151*	,203**
		Sig. (2-tailed)	,950	,841	,000	,299	.	,003	,462	,045	,975	,000	,000	,008	,046	,007
		N	178	176	178	176	178	175	178	178	169	175	175	174	176	178
	Q10_Q13	Correlation Coefficient	,259**	,165*	,204**	,428**	-,226**	1,000	,384**	,249**	,456**	-,123	,145	,364**	,360**	,220**
		Sig. (2-tailed)	,001	,029	,006	,000	,003	.	,000	,001	,000	,107	,056	,000	,000	,003
		N	177	176	177	175	175	177	177	176	168	174	173	172	174	176
	Q11_Q12	Correlation Coefficient	,250**	,121	-,053	,172*	,056	,384**	1,000	,161*	,151*	,157*	,229**	,175*	,080	,181*
		Sig. (2-tailed)	,001	,106	,477	,022	,462	,000	.	,031	,049	,037	,002	,021	,289	,015
		N	180	178	180	177	178	177	180	179	170	176	175	174	177	179
	Q18_Q19	Correlation Coefficient	-,073	-,006	,016	,419**	,151*	,249**	,161*	1,000	,555**	,110	,437**	,477**	,285**	,939**
		Sig. (2-tailed)	,330	,935	,835	,000	,045	,001	,031	.	,000	,147	,000	,000	,000	,000
		N	179	177	179	177	178	176	179	179	170	176	175	174	177	179
	Q20_Q21	Correlation Coefficient	,048	,043	,236**	,592**	,002	,456**	,151*	,555**	1,000	-,113	,324**	,579**	,417**	,452**
		Sig. (2-tailed)	,532	,580	,002	,000	,975	,000	,049	,000	.	,146	,000	,000	,000	,000
		N	170	169	170	168	169	168	170	170	170	167	168	167	168	170
	Q23_Q24_Q25	Correlation Coefficient	,223**	,059	-,155*	-,085	,328**	-,123	,157*	,110	-,113	1,000	,307**	,062	-,037	,187*
		Sig. (2-tailed)	,003	,442	,040	,264	,000	,107	,037	,147	,146	.	,000	,424	,631	,013
		N	176	174	176	175	175	174	176	176	167	176	172	171	174	176
	Q26_Q27	Correlation Coefficient	,078	,029	-,080	,339**	,324**	,145	,229**	,437**	,324**	,307**	1,000	,558**	,198**	,503**
		Sig. (2-tailed)	,306	,710	,294	,000	,000	,056	,002	,000	,000	,000	.	,000	,009	,000
		N	175	173	175	173	175	173	175	175	168	172	175	172	173	175
	Q28_Q29	Correlation Coefficient	,013	-,061	,025	,452**	,199**	,364**	,175*	,477**	,579**	,062	,558**	1,000	,308**	,458**
		Sig. (2-tailed)	,863	,423	,746	,000	,008	,000	,021	,000	,000	,424	,000	.	,000	,000
		N	174	174	174	172	174	172	174	174	167	171	172	174	172	174
	Q43_Q44	Correlation Coefficient	,086	-,042	,080	,455**	,151*	,360**	,080	,285**	,417**	-,037	,198**	,308**	1,000	,262**
		Sig. (2-tailed)	,258	,578	,289	,000	,046	,000	,289	,000	,000	,631	,009	,000	.	,000
		N	177	175	177	175	176	174	177	177	168	174	173	172	177	177
	Q17_Q18_Q19	Correlation Coefficient	-,054	-,036	-,041	,388**	,203**	,220**	,181*	,939**	,452**	,187*	,503**	,458**	,262**	1,000
		Sig. (2-tailed)	,472	,635	,583	,000	,007	,003	,015	,000	,000	,013	,000	,000	,000	.
		N	179	177	179	177	178	176	179	179	170	176	175	174	177	179

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

10.6.17 Correlation table for leanness

10.6.18 Regression tables (Quadratic models) for Leanness (Total sample)

10.6.18.1 Leanness and job stress

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,268[a]	,072	,061	1,239

a. Predictors: (Constant), leansqr, Leanness
b. Dependent Variable: Job stress

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	20,730	2	10,365	6,751	,002[b]
	Residual	267,146	174	1,535		
	Total	287,876	176			

a. Dependent Variable: Job stress
b. Predictors: (Constant), leansqr, Leanness

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	-3,185	1,775		-1,795	,074	-6,688	,318
	Leanness	3,458	,992	1,599	3,487	,001	1,501	5,415
	leansqr	-,500	,138	-1,664	-3,627	,000	-,773	-,228

a. Dependent Variable: Job stress

10.6.18.2 Leanness and job satisfaction

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,219[a]	,048	,037	1,00613

a. Predictors: (Constant), leansqr, Leanness
b. Dependent Variable: Job satisfaction

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8,872	2	4,436	4,382	,014[b]
	Residual	176,139	174	1,012		
	Total	185,011	176			

a. Dependent Variable: Job satisfaction
b. Predictors: (Constant), leansqr, Leanness

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	7,286	1,441		5,055	,000	4,441	10,131
	Leanness	-2,324	,805	-1,341	-2,886	,004	-3,913	-,735
	leansqr	,307	,112	1,275	2,744	,007	,086	,528

a. Dependent Variable: Job satisfaction

10.6.18.3 Leanness and Quantitative demands

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,157[a]	,025	,013	,97942

a. Predictors: (Constant), leansqr, Leanness
b. Dependent Variable: Quantitative demands

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4,255	2	2,127	2,218	,112[b]
	Residual	168,832	176	,959		
	Total	173,087	178			

a. Dependent Variable: Quantitative demands
b. Predictors: (Constant), leansqr, Leanness

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	,957	1,401		,683	,495	-1,807	3,722
	Leanness	,779	,783	,465	,996	,321	-,765	2,324
	leansqr	-,075	,109	-,321	-,687	,493	-,290	,140

a. Dependent Variable: Quantitative demands

10.6.18.4 Leanness and control of work pacing

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,250[a]	,063	,052	,96859

a. Predictors: (Constant), leansqr, Leanness
b. Dependent Variable: Control of work pacing

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11,089	2	5,545	5,910	,003[b]
	Residual	166,055	177	,938		
	Total	177,144	179			

a. Dependent Variable: Control of work pacing
b. Predictors: (Constant), leansqr, Leanness

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	3,194	1,385		2,307	,022	,462	5,927
	Leanness	-,484	,773	-,285	-,625	,532	-2,010	1,042
	leansqr	,124	,108	,528	1,157	,249	-,088	,337

a. Dependent Variable: Control of work pacing

10.6.18.5 Leanness and control of decisions

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,321[a]	,103	,093	,94877

a. Predictors: (Constant), leansqr, Leanness
b. Dependent Variable: Control of decisions

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	18,032	2	9,016	10,016	,000[b]
	Residual	156,629	174	,900		
	Total	174,661	176			

a. Dependent Variable: Control of decisions
b. Predictors: (Constant), leansqr, Leanness

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	6,465	1,373		4,709	,000	3,756	9,175
	Leanness	-2,657	,765	-1,564	-3,474	,001	-4,167	-1,147
	leansqr	,412	,106	1,747	3,879	,000	,202	,621

a. Dependent Variable: Control of decisions

10.6.18.6 Leanness and empowerment

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,466[a]	,217	,207	1,21111

a. Predictors: (Constant), leansqr, Leanness
b. Dependent Variable: Empowerment

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	67,823	2	33,912	23,119	,000[b]
	Residual	244,955	167	1,467		
	Total	312,778	169			

a. Dependent Variable: Empowerment
b. Predictors: (Constant), leansqr, Leanness

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	14,763	1,761		8,385	,000	11,287	18,240
	Leanness	-6,644	,982	-2,922	-6,764	,000	-8,583	-4,705
	leansqr	,895	,136	2,837	6,569	,000	,626	1,164

a. Dependent Variable: Empowerment