Job Design under Lean Manufacturing and the Quality of Working Life: a Job Demands and Resources Perspective

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Declaration

I hereby certify that this material, which I now submit for assessment on the programme of study leading to the award of Doctor of Philosophy is entirely my own work, and that I have exercised reasonable care to ensure that the work is original, and does not to the best of my knowledge breach any law of copyright, and has not been taken from the work of others save and to the extent that such work has been cited and acknowledged within the text of my work.

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Job Design under Lean Manufacturing and the Quality of Working Life: a Job Demands and Resources Perspective

Sarah-Jane Cullinane

Abstract

Studies to date which examine the quality of working life under lean manufacturing have yielded contradictory findings, whereby positive, negative and contingent effects on employee well-being have been demonstrated. A large contributor to these inconsistencies is the absence of an applicable model of job design which captures the complex socio-technical nature of this context. This research proposes and tests a model of job design under lean manufacturing using the Job Demands-Resources framework in order to capture the distinct motivational and health-impairing potential of this context. Cross-sectional data was collected from 200 employees working in a multi-national pharmaceutical manufacturing organisation with extensive lean usage. The findings supported hypotheses relating to the direct and interactive effects of lean-specific resources and demands in the prediction of employee work engagement and exhaustion. In addition, the findings from a multilevel daily diary study using a subsample of 64 employees demonstrated that jobs designed according to lean manufacturing principles facilitate job crafting activities on a daily basis. Furthermore the findings support the hypothesised relationship between daily job crafting (resource and challenge-seeking) and daily work engagement. Overall, the three studies presented in this thesis support the application and adaption of the JD-R framework to the lean manufacturing context at both stable and temporal levels. It supports recent claims that this type of work environment has both positive and negative effects for employees, and provides solutions as to how lean-specific resources and demands can be balanced to create jobs which are equally enriched and efficient. Recommendations are made for practitioners using lean manufacturing systems which encourage them to stimulate the motivational potential of the demands associated with this high-involvement, fast-paced work environment by complementing them with the appropriate job resources.

Chapter One

Introduction

1.1 Introduction

Reflecting upon the changes in the nature of work over recent decades, Oldham and Hackman (2010) note that the scope, challenge and autonomy of front-line work is fundamentally changing. As workplaces become more unpredictable and uncertain, greater emphasis is placed on the need for flexibility, team-working, interdependency and integration in the modern organisation. Such transformations are, however, largely neglected in current applications of job design theory (Grant & Parker, 2009; Grant, Fried, Parker & Frese, 2010; Morgeson & Campion, 2002; Parker, Wall & Cordery, 2001; Rousseau & Fried, 2001). As job design is largely predetermined by the organisational context, researchers in this area are encouraged to recognise and appreciate the influence of context, and not allow it to be 'controlled away' (Johns, 2006, p.389). In this thesis, the context of interest is that of lean manufacturing. This multidimensional approach to manufacturing encompasses a wide variety of management practices within an integrated system dedicated to minimising waste (Shah & Ward, 2003; 2007). Lean manufacturing has become one of the most widely used production systems internationally as organisations come under increased pressure to compete on cost, quality, and service. Its popularity stems from the consistent associations made between its practices and improvements in operational and organisational performance (Brown, Collins & McCombs, 2006; Cua, McKone & Schroeder, 2001; Fullerton & Wempe, 2009).

The way in which jobs are designed under lean manufacturing and how this work environment is subsequently experienced by employees has been a contentious issue among scholars and practitioners. From their roots in socio-technical systems and neo-Taylorism, lean systems are intended to promote multi-skilled operators organised into small teams, who are responsible for quality, continuous improvement and problem solving (Niepce & Molleman, 1998). On the one hand, advocates of lean manufacturing claim that employees within this context work ‘smarter’ rather than harder and experience less work-related stress than their counterparts under mass production or Tayloristic systems (Wickens, 1995; Womack, Jones & Roos, 1990). On the other hand, critics argue that this managerial approach leads to work intensification for employees (Delbridge, Turnbull & Wilkinson, 1992) and represents ‘management by stress’ (Delbridge & Turnbull, 1992; Parker & Slaughter, 1988). Despite these claims, surprisingly little empirical evidence exists to answer the on-going debate as to whether lean is ‘mean’ (Anderson-Connolly, Grunberg, Greenberg & Moore, 2002; Parker, 2003). Reviews of existing studies mainly report negative effects on both working conditions and subsequent health, although these effects are primarily evident for manual work with low levels of complexity (Hasle, Bojesen, Jensen & Bramming, 2012; Landsbergis, Cahill & Schnall, 1999). An increasing number of studies are, however, finding that lean manufacturing has a mixture of positive and negative effects on working conditions and well-being (Anderson-Connolly et al., 2002; Conti, Angelis, Cooper, Faragher & Gill, 2006; Godard, 2001; Jackson & Mullarkey, 2000; Seppällä & Klemola, 2004). Indeed some have even demonstrated that employees in jobs with higher complexity experienced job improvements such as increased participation in decision making and improved completeness (Parker, 2003; Schouteten & Benders, 2004).

A large contributor to the contradictory nature of evidence is the absence of an applicable model of job design which captures the complex socio-technical nature of lean manufacturing. Models such as the job demands-control model (JD-C; Karasek, 1979) and the job characteristics model (JCM; Hackman & Oldham, 1976) were found to be limited in their application to lean manufacturing as they exclude important job characteristics relevant to this context such as task interdependency, boundary control and problem solving (Conti et al., 2006; de Treville & Antonakis, 2006; Jackson, Wall, Martin & Davids, 1993). In addition, the use of these models assumes that all job characteristics within the lean context impact employee well-being through one single (motivational or strain) process. This has led to inconsistent results when examining both positive and negative outcomes of lean manufacturing (e.g. Jackson & Mullarkey, 2000).

1.1.1 Aims and Objectives

This thesis consists of three separate studies, one conceptual study and two empirical studies. These studies aim to identify and assess a model of job design under lean manufacturing which incorporates the claims made by both its advocates and critics. In doing so, it will demonstrate the long term everyday implications of lean manufacturing for job design and examine how jobs designed according to lean principles impact employee well-being. The job demands-resources model (JD-R; Demerouti, Bakker, Nachreiner & Schaufeli, 2001) is adopted as it facilitates the examination of two distinct psychological processes which occur simultaneously as a result of lean job design, one which is motivational in nature, and one which is health-impairing. This model includes two specific sets of working conditions, job demands and job resources, in its prediction of employee well-being. These conditions can be selected according to the relevant occupational group, and are therefore not constrained by varieties in context (Hakanen & Roodt, 2010). Recent advancements of the job characteristics model (JCM; Campion, Mumford, Morgeson & Nahrgang, 2005; Morgeson & Humphrey, 2008) will also be used to expand the JD-R model. Specifically, both models will be integrated into an overarching model to enable the differentiation between various levels of job design under lean manufacturing and the identification of mechanisms through which it impacts psychosocial outcomes for employees. Using the JD-R framework, the prominent job resources, job demands and job challenges applicable to lean manufacturing will be identified, and their impact on motivational and negative health-related outcomes will be examined. In addition to addressing the stable processes of the JD-R model within this context, this research will extend this to the temporal level by examining the daily job redesign activities employees engage in to facilitate their personal well-being. These redesign activities are known as 'job crafting' which relates to the changes or modifications that employees carry out in their job as a means of adapting to the challenges they face and satisfying their individual needs (Berg, Wrzesniewski & Dutton, 2010; Wrzesniewski & Dutton, 2001). A within-person approach will be used to examine how employees utilise aspects of their job design which are predetermined by lean manufacturing principles to craft their job on a daily basis.

1.1.2 Research Contributions

This research contributes to the literature on lean manufacturing, job design and occupational health in several ways. First, although the JD-R model has been frequently used across a wide variety of contexts to examine the motivational and health-implications of particular jobs, no study to date has identified this framework as critical in terms of simultaneously capturing both the positive and negative effects of lean manufacturing for employees. The adaption of this framework to the lean manufacturing context highlights the need to discriminate between its resultant job characteristics (i.e. resources, challenges and demands) and their unique roles in predicting motivational and health impairment outcomes for employees. Second, the interplay between positive and negative working conditions under lean manufacturing are examined for the first time. This calls into question the established perspective of lean-specific demands as solely damaging for the quality of working-life (e.g. Landsbergis et al., 1999). These dual processes examined by the research model incorporate the claims of both critics and advocates, and help to explain the findings of existing studies which report both positive and negative outcomes of lean manufacturing for employees (Anderson-Connolly et al., 2002; Conti et al., 2006; Godard, 2001; Jackson & Mullarkey, 2000; Seppällä & Klemola, 2004). Third, using the JD-R framework this research adds to the scarce body of literature regarding contextual facilitators of job crafting by examining its relationship with previously unexamined job resources, demands and challenges encountered by employees under lean manufacturing. This research examines, for the first time, the impact of job design on job crafting using the recently established three-dimensional differentiation of job characteristics (i.e. job resources, challenges and demands; Crawford, LePine & Rich, 2010; Van den Broeck, De Cuyper, De Witte & Vansteenkiste, 2010), as it simultaneously examines the unique impact of these characteristics on job crafting activities. Overall, this research allows us to move beyond the question as to whether lean has positive or negative effects, and toward the question of how to balance lean-resources and lean-demands to create jobs which are equally enriched and efficient. At a more general level, this research demonstrates the fundamental influence of context in determining job characteristics which impact the quality of working life for employees. In doing so it also shows how contingent models of job design can be created to more accurately fit an organisational context.

1.1.3 Thesis Outline

The three studies presented in this thesis examine the processes through which job characteristics resultant from lean manufacturing impact the quality of working life for employees from a conceptual, stable and temporal perspective. Study 1 is a theoretical examination of the process through which job design impacts employee outcomes under lean manufacturing. This study adapts and integrates both the JCM (Hackman & Oldham, 1976) and the JD-R model (Demerouti et al., 2001). In doing so, it demonstrates the long term implications of lean manufacturing for job design and shows how jobs designed according to lean manufacturing principles influence motivational and health-impairment outcomes. From this, a research agenda is created in order to improve our understanding of the employee experience of lean work and to promote the creation of contextualised job design models. Building on this proposed model, Study 2 empirically tests the direct effects of lean-specific job resources and demands as well as their interactive effects on motivational and health-impairment outcomes. This study used a cross-sectional design with a sample of 200 employees from a multi-national pharmaceutical manufacturer with extensive levels of long term lean usage. Finally, Study 3 uses a within-person design to examine the daily influence of lean-specific job characteristics on job crafting behaviour, and the day-level relationship between job crafting and work engagement. Specifically, a daily diary study was carried out over four working days with 64 employees from the same pharmaceutical organisation to test the multi-level hypothesised relationships. Prior to presenting the three studies, the theoretical background of lean manufacturing and the debate regarding its effects on the quality of working life for employees are presented. Following from this the overall research objective and specific research questions which are addressed by the three studies are outlined. This chapter then discusses the methodology underlying the research in terms of its design, administration and analysis, followed by a brief overview of the three studies. Next, the three studies are formally presented. Finally, the thesis concludes with an overall discussion chapter which evaluates the findings and contribution of the three studies in light of the research questions. Recommendations for future research and management practice will also be presented.

1.2 Theoretical Background

1.2.1 Lean Manufacturing

The origins of lean manufacturing can be attributed to over 50 years of innovative developments at Toyota Motor Corporation which sought to remove overburden (muri) and inconsistency (mura), and to eliminate waste (muda) in the production process (Monden, 1983; Ohno, 1988; Shingo, 1981). Although originally designed for use in manufacturing, its principles have also been adopted in the service industry (Abdi, Shavarini & Hoseini, 2006), the public sector (Kollberg, Dahlgaard & Brehmer, 2006) and knowledge work (Staats, Brunner & Upton, 2011). Since the original coining of the term in the late 1980s (Krafcik, 1988; Womack et al., 1990), its meaning and measurement has been a hotly debated topic of inquiry. The precise meaning of lean manufacturing has alternated within both academia and popular discourse. It has been defined as a system which is dedicated to minimising waste (Narasimhan, Swink & Kim, 2006), to buffer inventories and ensure system variability (de Treville & Antonakis, 2006), to one which simply implements certain practices such as Just-in-Time (JIT) manufacturing (Gaither & Frazier, 2002). Consensus now exists that lean is a multidimensional approach to manufacturing which pursues added value at the strategic level and uses tools to eliminate waste at the operational level (Hasle et al., 2012; Hines, Holweg & Rich, 2004; Shah & Ward, 2003; 2007).

Current perspectives which consider lean manufacturing as a socio-technical system, have broadened its focus beyond shopfloor tools to reflect a wider management philosophy which incorporates both technical operational tools and human resource practices (Birdi et al., 2008; de Menezes, Wood & Gelade, 2010). Its technical tools are used to reduce waste in human effort, time to market and manufacturing space. From a human resources perspective, lean is designed to promote more challenging work with greater responsibility for front-line employees through the use of cross-functional and self-directed work teams (MacDuffie & Pil, 1995; Womack et al., 1990). Recent research has demonstrated that organisations which have adopted this integrative approach using both human resource and operations management practices outperform those using solely technical practices (Birdi et al., 2008). For example, de Menezes et al. (2010) argue that an operational focus is critical to the success of empowerment practices and vice versa. In the process of developing a comprehensive measurement tool for lean manufacturing, Shah and Ward (2007) identified and defined the most prominent lean practices that are currently in use by manufacturing organisations. These practices include supplier feedback, JIT delivery by suppliers, supplier development, customer involvement, pull systems, continuous flow, set-up time reduction, total productive/preventative maintenance, statistical process control and employee involvement (See Table 3.1 on p. 63 for description of each practice). All of these practices were found to be highly inter-correlated and therefore have complementary and synergistic effects when combined. However, Shah and Ward (2007) note the difficulty in implementing all practices simultaneously, making an ideal combination difficult to implement in practice. Therefore, wide variations exist across organisations and industries in their implementation approach and subsequent organisational outcomes.

1.2.2 Employee Well-Being under Lean Manufacturing

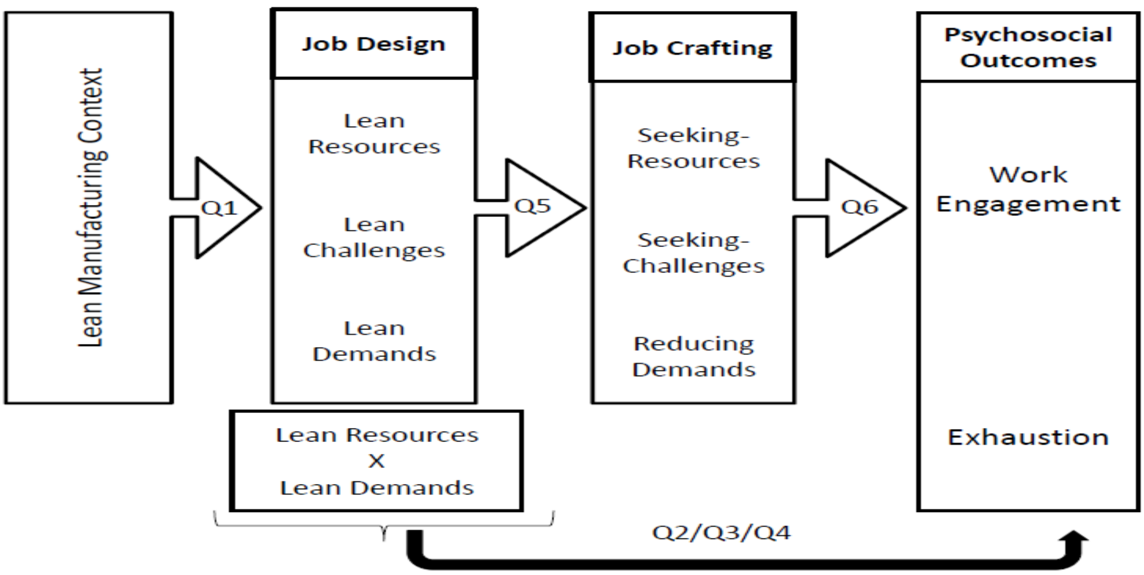
The manner in which lean manufacturing has been operationalised has had a substantial influence on research findings and conclusions regarding its positive and negative effects on employee well-being. Of these studies, some have yielded findings which demonstrate solely negative outcomes (e.g. Parker, 2003; Sprigg & Jackson, 2006), while others reveal contingent outcomes where improved well-being is dependent on specific management practices (e.g. Anderson-Connolly et al., 2002; Conti et al., 2006; Jackson & Mullarkey, 2000). The studies which report solely negative findings (Parker, 2003; Sprigg & Jackson,

2006) focused specifically on the impact of individual lean practices such as moving assembly lines and performance monitoring on job characteristics and employee well-being. These specific practices were found to negatively impact employee well-being as they led to a deterioration of job characteristics necessary for job enrichment such as autonomy and skill utilisation. However, a number of the practices examined in these studies are also commonly used in non-lean contexts, such as mass production, which limits the generalisation of their findings to lean manufacturing. In contrast, studies which demonstrate contingent effects of lean manufacturing on employee well-being found that positive outcomes are dependent on specific decisions regarding its implementation and day-to-day management (Anderson-Connolly et al., 2002; Conti et al., 2006; Jackson & Mullarkey, 2000). Unlike the studies which assessed individual lean practices, these studies operationalised lean manufacturing as a more unified system, taking into account both its technical and human resource practices. For example, Jackson and Mullarkey (2000) compared two groups in relation to their job characteristics and subsequent well-being. One group was exposed to a number of lean practices such as collective responsibility and continuous flow while the other one was a conventional batch-producing group from the same company. The authors found that the group with exposure to an array of lean practices experienced greater levels of role breadth, task variety, co-worker trust and all work demands, yet timing control and group cohesiveness were decreased. As a result, they found no overall difference between lean and non-lean groups in terms of well-being (i.e. job strain and satisfaction). Conti et al. (2006) categorised ten lean practices (Powell, 1995) into control practices, demand practices and support practices in order to test their relationship with employee stress across multiple industries. They found support for a number of the hypothesised relationships whereby demand practices (e.g. blame for defects) increased employee stress, and control (e.g. participation) and support practices (e.g. team-working) reduced stress for employees. Based on the increasing number of these studies which demonstrate both positive and negative effects of lean manufacturing on working conditions and well-being, 'an unambiguous negative or causal effect of lean cannot be established' (Hasle et al., 2012, p.845). Therefore, since lean manufacturing promotes greater levels of both enriching and exploitative job characteristics in comparison to mass or Tayloristic approaches to production, there is a clear need for an open and flexible model which accounts for the 'double-edged' nature of this working environment.

1.3 Research Questions

Building on the JD-R framework, the primary objective of this research is to propose and test both stable and temporal models which explain how job design resulting from lean manufacturing impacts the quality of working life for employees. An overview of the research questions addressed in this thesis is presented in the overall research model depicted in Figure 1.1.

Figure 1.1 Research Model: The Impact of Job Design on Employee Outcomes under Lean Manufacturing Note. (Q1-Q6 refers to Research Questions 1-6)



Question 1: *How are jobs designed under lean manufacturing?*

As previously mentioned, the neglect of context in organisational behaviour research is a growing concern (Grant et al., 2010a; Rousseau & Fried, 2001). In particular, the context of lean manufacturing brings to light the limitations and problems associated with context-free job design models such as the JD-C model (Karasek, 1979) and the JCM (Hackman & Oldham, 1976). These models are said to overlook a number of important and relevant job characteristics in the lean manufacturing context (Anderson-Connolly et al., 2002; Conti et al., 2006; de Treville & Antonakis, 2006; Jackson et al., 1993; Wall & Martin, 1987). In adopting the JD-R framework for this research, an extensive range of relevant job characteristics can not only be identified but also differentiated according to their impact on employee psychosocial outcomes. The differentiations made between these lean-specific job characteristics (i.e. job resources, job demands and job challenges) are premised on strong evidence which demonstrates their differential impact on motivational and health-impairment outcomes (Bakker & Demerouti, 2007; Crawford et al., 2010; Demerouti et al., 2001; Halbesleben, 2010; Van den Broeck et al., 2010). Job resources refer to those physical, psychological, social or organisational aspects of the job that are either functional in achieving work goals, reducing job demands and the associated physiological and psychological costs, or stimulating personal growth, learning and development (Demerouti et al., 2001). These “supporting conditions” which are required by employees to carry out their tasks in the lean manufacturing context (Oliver & Wilkinson, 1992) are often overlooked in the dialogue surrounding this work environment. Job resources that have been previously identified and assessed as relevant aspects of lean design include team working (Conti et al., 2006), skill utilisation (Sprigg & Jackson, 2006), autonomy (Anderson-Connolly et al., 2002), social climate (Jackson & Mullarkey, 2000) and participation (Parker, 2003). The three studies presented in this thesis identify training, feedback, boundary control, skill variety, skill utilisation and social support as salient job resources within the context of lean manufacturing based on literature review and exploratory field work. Their unique relevance to this context is discussed within the studies presented in this thesis and are outlined in Table 1.1.

Table 1.1 Summary of Job Resource Examined Across the Studies

Resources	**Relevance in Lean Manufacturing Context**
Training (Study 2)	Increased use of multi-skilling/cross-functional activities, work groups for quality improvement, product development and task flexibility, training in quality, customer services and people management (Adler, 1990; de Treville & Antonakis, 2006; Kabst, Larsen & Bramming, 1996).
Feedback (Study 1, 2)	Regular feedback on performance to employees through the use of statistical process controls, visual display and frequent team meetings (drumbeat meetings) used to track process quality issues such as defect rates, frequency of machine breakdown and monitor production progress (Conti et al., 2006; de Treville & Antonakis, 2006; Forza, 1996; Greller & Herold, 1975).
Boundary Control (Study 1, 2)	Employees are involved in activities associated with the role of traditional supervisory or front-line manager (e.g. machine inspection, maintenance, quality assurance) (Jackson & Mullarkey, 2000; Sprigg & Jackson, 2006).
Skill Variety and Utilisation (Study 1, 3)	Multi-skilling activities used include cross-training, job rotation, problem solving, and participation in decision making (Adler & Cole, 1993; MacDuffie, 1995; Mullarkey, Jackson & Parker, 1995). Managers are instructed to answer questions with questions to encourage decision making by subordinates (Adler, 1990).
Social Interaction (Study 1)	Design of cross-functional production cells made up of interdependent teams increases levels of interaction and subsequent support between employees (Jackson & Mullarkey, 2000; Mullarkey et al., 1995).

Job demands refer to those physical, psychological, organisational and social aspects of the job that require sustained physical/psychological effort or skills and are therefore associated with physical/psychological costs (e.g. high work pressure, an unfavourable physical environment, emotionally demanding interactions with clients) (Bakker & Demerouti, 2007). There is no shortage of evidence to suggest that lean manufacturing is a demanding working environment (Hasle et al., 2012; Landsbergis et al., 1999), with the potential to promote standardised, short-cycled, and heavily loaded jobs (Rinehart, Huxley & Robertson, 1997). Demands previously identified and assessed as relevant aspects of lean design include production pace, work intensity, monitoring pressures, and team conflict (Conti et al., 2006; Jackson & Mullarkey, 2000; Sprigg & Jackson, 2006). The three studies presented in this thesis identify physical demands, felt accountability, production pace, monitoring demands and task interdependency as salient job demands within the context of lean manufacturing based on literature review and exploratory field work. Their unique relevance to this context is discussed within the presented studies and outlined in Table 1.2.

Finally, job challenges are a recent addition to the JD-R model as new research findings have emerged which demonstrates that job demands can be perceived either as hindrances or challenges (Crawford et al., 2010; Van den Broeck et al., 2010). The results of these studies reveal that job demands which are perceived as challenges have motivational rather than health-impairment potential for employees. This type of demand is also differentiated by a number of researchers examining lean manufacturing which refer to them as “thinking work” (MacDuffie, 1995), “psychological demands” (Conti & Gill, 1998) or “cognitive demands” (Wall, Corbett, Clegg, Jackson & Martin, 1990). As a result of these demands, employees are required to have broader contextual knowledge of production tasks and link this knowledge to their assigned processes in order to maintain a repetitive flow of production. Challenges previously identified and assessed as relevant aspects of lean design include decision making (MacDuffie & Pil, 1995), problem solving (Delbridge, Lowe & Oliver, 2000) and production responsibility (Jackson & Mullarkey, 2000). The three studies presented in this thesis also identify problem solving and production responsibility as salient job challenges within the context of lean manufacturing based on literature review and exploratory field work. Their unique relevance to this context is discussed within the presented studies and outlined in Table 1.2.

Table 1.2 Summary of Job Demands and Challenges Examined Across the Studies

Job Demands	**Relevance in Lean Manufacturing Context**
Felt Accountability (Study 2, 3)	Mechanisms of quality control and feedback, in addition to team-working practices heightens the level of peer surveillance and individual accountability (Sewell & Wilkinson, 1992; Turnbull, 1988).
Task Interdependency (Study 2, 3)	Multidisciplinary production units whereby interdependent tasks are grouped together and all activity is oriented toward the production of a single product or family of products. This is intended to maximise group autonomy and reduce the need for decision making outside the immediate work group (Klein, 1991; Susman, 1976).
Production Pace (Study 1, 2)	Short-cycle time and moving assembly lines increase the speed and volume of work for operators (Jackson & Mullarkey, 2000; Sprigg & Jackson, 2006).
Physical Demands (Study 1)	Short-cycle time and moving assembly lines increase the physical pressures on operators, although this is more prominent in automobile manufacturing (MacDuffie, 1995).
Monitoring Demands (Study 1)	Demands to get product right first time and delivered on time, and the requirements to mind multiple machines at one time puts pressure on employees to stay alert and to not make mistakes (Jackson & Mullarkey, 2000).
Job Challenges	**Relevance in Lean Manufacturing Context**
Problem solving (Study 1, 2, 3)	‘Active problem solving orientation’ is required to ensure the prevention of and recovery from errors in the production process (Wall et al., 1990a).
Production Responsibility (Study 1)	Employees are responsible for decision making and problem solving in dealing with uncertainty and variability in the quality of raw materials, human performance and machine efficiency (MacDuffie & Pil, 1995).

Question 2: *How do lean-specific job resources impact employee well-being?*

According to the JD-R model, a motivational process takes place in which job resources satisfy employees' basic needs for autonomy, competence and relatedness and therefore foster motivational outcomes such as work engagement (Hakanen & Roodt 2010; Mauno, Kinnunen & Ruokolainen, 2007). Work engagement is defined as a positive, fulfilling, work-related state of mind characterised by vigour, dedication and absorption (Schaufeli, Salanova, González-Romá & Bakker, 2002), and is the motivational outcome of interest in this thesis. Its relevance to this research, which examines the effects of job design under lean manufacturing, stems from its demonstrated ability to enable employees to simultaneously meet and exceed their work goals while maintaining their personal well-being (for an overview see Demerouti & Cropanzano, 2010). Under the JD-R framework, job resources which have been found to predict motivational outcomes to date include performance feedback, social support, supervisory coaching (Schaufeli & Bakker, 2004), job control, information, innovative climate and social climate (Hakanen, Bakker & Schaufeli, 2006), and reward, recognition and value fit (Koyuncu, Burke & Fiksenbaum, 2006). Some evidence also demonstrates cross-linkages between job resources and ill-health, whereby a lack of resources leads to increased burnout (e.g. Schaufeli & Bakker, 2004). Many of the job resources presented in the previous section have been found to positively impact employees in the lean manufacturing context either through reducing stress or improving satisfaction (Anderson-Connolly et al., 2002; Conti et al., 2006; Jackson & Mullarkey, 2000; Parker, 2003; Sprigg & Jackson, 2006). Therefore, following the identification of prominent job resources relevant to the lean context, the studies presented here discuss and examine the motivational and health-improving potential of these resources by investigating their relationship with work engagement and exhaustion for employees. A summary of all hypotheses relating to the impact of job resources under lean manufacturing are outlined in Table 1.3 and presented in Studies 1 and 2.

Question 3: *How do lean-specific job demands impact employee well-being?*

The JD-R model also proposes a health impairment process according to which high job demands exhaust employees' mental and physical resources leading to burnout and eventually to ill-health. Exhaustion is a consequence of intense physical, affective and cognitive strain whereby employees' energy is drained, leaving them incapable of performing their job (Demerouti, Bakker, Nachreiner & Ebbinghaus, 2002). It is the most central quality and most obvious manifestation of burnout and is therefore more predictive of stress-related health outcomes than other burnout components (i.e. cynicism and inefficacy) (Maslach, Schaufeli & Leiter, 2001). Studies using the JD-R framework have consistently demonstrated that high job demands such as workload, emotional demands, and work-home conflict exhaust employees' mental and physical resources and therefore lead to a depletion of energy and subsequent health problems (Bakker, Demerouti & Euwema, 2005; Bakker, Demerouti & Verbeke, 2004; Bakker, van Emmerick & van Riet, 2008). However, most studies examining potential cross linkages found either no relationship (either positive or negative) between job demands and work engagement (e.g. Hakanen et al., 2006; Schaufeli & Bakker, 2004; Schaufeli, Bakker & van Rhenen, 2009) or a weak relationship (Hu, Schaufeli & Taris, 2011). Many of the demands outlined in the previous section have also been found to increase employee strain in the context of lean manufacturing (Conti et al., 2006; Jackson & Mullarkey 2000; Sprigg & Jackson 2006). In terms of general job design, demands which are perceived as challenges have alternatively been found to predict positive outcomes including work engagement (Crawford et al., 2010; Van den Broeck et al., 2010). The process through which this occurs is triggered by positive emotions and cognitions that result in active and problem-focused coping styles. Indeed recent additions to the JCM include demands such as problem solving and information processing which are predicted to have both demanding and satisfying attributes (Morgeson & Humphrey, 2008), although little empirical research exists which has demonstrated their effects. More generally, demands of this challenging nature such as decision making (MacDuffie & Pil, 1995), problem solving (Delbridge, Lowe & Oliver, 2000) and production responsibility (Jackson & Mullarkey, 2000) have been associated with the lean working environment. However predictions and evidence regarding their relationship with employee outcomes is scarce. Following the identification of prominent job demands and challenges relevant to the lean context, the studies presented in this thesis discuss and examine their health-impairing and motivational potential by assessing their relationship with exhaustion and work engagement for employees. A summary of all hypotheses relating to the impact of job demands and challenges are outlined in Table 1.3 and presented in Studies 1 and 2.

Question 4: *How does the interplay of job resources and job demands impact employee well-being under lean manufacturing?*

On the basis of the conservation of resources theory (COR; Hobfoll, 2002) and the strain and learning hypotheses of the JD-C model (Karasek & Theorell, 1990), the JD-R model also proposes that job resources buffer the negative effects of job demands on health-related employee outcomes (Bakker & Demerouti, 2007). Using the JD-R framework, a number of studies have found support for this buffer effect on negative outcomes such as burnout across multiple occupations (Bakker, Hakanen, Demerouti & Xanthopoulou, 2004). In particular, this effect was found to occur among home care staff (de Jonge, le Blanc, Peeters & Noordam, 2008; Xanthopoulou at al., 2007) and higher education teachers (Bakker et al., 2005). More recently the JD-R model has been extended to propose a motivational hypothesis whereby job resources have a stronger relationship with motivational outcomes in the face of high job demands. This coping hypothesis suggests that job resources supply strategies for dealing with job demands, and therefore are less of a concern to individuals experiencing little to no demands in their job (Bakker et al., 2007; Seers, McGee, Serey & Graen, 1983). Therefore, the motivational potential of 'active jobs' (Karasek & Theorell, 1990) stems from their ability to combine demanding work with adequate resources. In support of this, Hakanen et al. (2005) found that variability in professional skills increased work engagement when employees were confronted with high qualitative workload and also diminished the negative effect of high workload on engagement. Similarly Bakker et al. (2007) found that job resources particularly influenced teachers' work engagement when pupil misbehaviour was an important job demand. Although these interactive effects between job resources and job demands remain untested in the lean manufacturing context, a number of authors have indirectly referred to similar combinations of job characteristics which aid employees in dealing with uncertainty and variability in the production process and provide a healthier work environment (e.g. MacDuffie & Pil 1995; Womack et al., 1990). Therefore, this research examines the interplay between lean resources and demands as an antecedent of motivational and health-related outcomes for employees in this context. A summary of all hypotheses relating to the interaction between job resources and demands are outlined in Table 1.3 and presented in Studies 1 and 2.

Question 5: *What characteristics of job design under lean manufacturing facilitate/inhibit employee job crafting behaviour?*

Research to date which assesses working conditions under lean manufacturing has focused solely on the well-being implications of job redesign by management. However, the activities employees engage in to modify their work on an individual basis, and the repercussions of these activities for their well-being, have yet to be considered in this context. Job crafting is referred to as a ‘proactive person-environment fit behaviour’ (Grant & Parker, 2009, p. 352). It relates to the changes or modifications that employees carry out in their job as a means of adapting to the challenges they face and satisfying their individual needs (Berg et al., 2010; Wrzesniewski & Dutton, 2001). The provision of predetermined job characteristics serve as cues for employees regarding whether it is legitimate for them to actively shape their jobs in these ways (Salancik & Pfeffer, 1978). Employees read cues regarding the physical boundaries of their jobs and respond accordingly either by altering these boundaries or remaining a passive incumbent of their job role. For example, Petrou and colleagues found that the combination of high work pressure and high autonomy (i.e. active jobs) at the daily level increased the likelihood of employees seeking further resources and reducing their demands on that day (Petrou, Demerouti, Peeters, Schaufeli & Hetland, 2012). Tims and colleagues also found that employee crafting of structural and social job resources led to an increase in perceived structural (e.g. autonomy) and social (e.g. support) resources over a two month period (Tims, Bakker & Derks, 2013). Similarly Leana and colleagues found that work discretion was positively related to individual job crafting for teachers and their aides (Leana, Appelbaum & Shevchuk, 2009). The COR theory (Hobfoll, 2002) claims that individuals with greater resources have more capability to orchestrate resource gain while a loss of resources can evoke avoidance and loss prevention strategies by employees. Therefore this thesis examines how employees utilise aspects of their job design which are constrained by lean manufacturing principles to actively widen the availability of resources and challenges within their job and reduce their exposure to job demands. A summary of all hypotheses relating to the relationship between job design under lean manufacturing and job crafting are outlined in Table 1.3 and presented in Study 3.

Question 6: *Do employees regularly craft their job under lean manufacturing to facilitate their personal engagement?*

Engagement does not just “happen” to employees; rather employees have the ability to actively create engagement experiences (Salanova, Schaufeli, Xanthopoulou & Bakker, 2010; Sonnentag, Dormann & Demerouti, 2010). Employees are likely to revise their jobs in ways that fit their work orientation as a means of creating meaning in their job and identifying with their work (Wrzesniewski & Dutton, 2001). Employees utilise often-hidden degrees of freedom in their job to customise it to their own sense of what the job should be. Individuals who craft their work environment in order to align their job demands and resources with their own abilities and needs have been found to facilitate their personal work engagement (Bakker, Tims & Derks, 2012; Nielsen & Abildgaard, 2012; Petrou et al., 2012; Tims & Bakker, 2010). Therefore, on the basis of person-environment fit theory (Edwards, 2008), this congruence between needs and environment achieved through job crafting is expected to promote employees’ engagement at work. In addition, a number of authors have established a positive relationship between proactive behaviours such as job crafting, personal initiative, feedback-seeking and self-development, and positive outcomes such as work engagement and positive emotion (Anseel, Beathy, Shen, Lievens & Sackett, 2013; Bakker et al., 2012; Hyvonen, Feldt, Salmela-Aro, Kinnunen & Makikangas, 2009; Ko, 2012; Tims et al., 2013). Job crafting has yet to be identified as a facilitator of employee well-being under lean manufacturing. Considering the job characteristics promoted in this context and the motivational potential of job crafting in general, these individual redesign activities might be a useful means through which managers could promote employee engagement within lean organisations. Therefore this thesis considers how ‘bottom-up’ job redesign by employees in the form of job crafting influences their work engagement. A summary of all hypotheses relating to the relationship between job crafting and work engagement are outlined in Table 1.3 and presented in Study 3.

Table 1.3 Summary of Research Propositions and Hypotheses

Proposition/Hypothesis	**Study**
1. Lean-specific job resources will be (a) positively associated with motivational outcomes, and (b) negatively associated with negative health-related outcomes	1, 2
2. Lean-specific job demands will be positively associated with negative health-related outcomes	1, 2
3. Lean-specific job demands will moderate the relationship between lean-specific job resources and motivational outcomes such that the relationship will be strengthened given high rather than low lean-specific demands	1, 2
4. Lean-specific job resources will moderate the relationship between lean-specific job demands and negative health-related outcomes such that the relationship will be weakened given high rather than low lean-specific resources	1, 2
5. Day-level skill utilisation is positively related to day-level seeking resources by employees	3
6. Day-level problem solving is positively related to day-level seeking challenges by employees	3
7. Day-level felt accountability is positively related to day-level reducing demands by employees	3
8. (a) Day-level seeking resources and (b) day-level seeking challenges are positively related to day-level work engagement, and (c) day-level reducing demands are negatively related to day-level work engagement	3
9. The relationship between day-level skill utilisation and day-level seeking resources is moderated by general-level task interdependence whereby skill utilisation is positively related with seeking resources at the daily level when the general-level of task interdependency is perceived to be low rather than high.	3
10. The relationship between day-level problem solving and day-level seeking challenges is moderated by general-level task interdependence whereby problem solving is positively related with seeking challenges at the daily level when the general-level of task interdependency is perceived to be low rather than high.	3

1.4 Methodology

1.4.1 Research Development and Design

1.4.1.1 Theory Development. A research problem which is both unsolved and of interest requires theory which explains it (Pillutla & Thau, 2013). The research problem of interest here concerns the inconsistent findings across previous studies which assess the quality of working life under lean manufacturing, and the lack of an appropriate model which captures the motivational and health-impairing potential of jobs designed in this context. In response to this, the first study sought to dispel some of the confusion surrounding this debate. In addition to presenting the contradictory findings of existing research, the study offers a solution in the form of a conceptual integration of the literature and a subsequent research agenda (van Knippenberg, 2011). First, the job characteristics applicable to this context were identified following a comprehensive review of the literature surrounding lean manufacturing. Next, using an integration of the JD-R model and recent developments of the JCM, the study outlines how these characteristics impact both motivational and negative health-related outcomes for employees. Support for each of the proposed relationships is provided using evidence from studies examining the well-being implications of jobs under lean manufacturing, the processes outlined in the JD-R model, and the impact of job design more generally. Finally, on the basis of the proposed model, a research agenda is outlined which makes recommendations for how the model can be evaluated and subsequently refined (Ferris, Hochwarter & Buckley, 2011). For example, methods for incorporating context (both lean manufacturing and alternatives) are outlined and additional job characteristics, mediators and organisational outcomes are recommended for consideration.

1.4.1.2 Theory Testing. Growing preoccupation with developing new theory has resulted in the neglect of activities necessary for scientific advancement including theory testing and empirical replications of proposed relationships (Ferris et al., 2011). Ferris and colleagues (2011) claim that this obsession with revelatory contributions to theory has downgraded theory testing and its incremental contributions to an inferior role. As a result, opportunities for validating and developing existing theory have been inhibited. Theory testing is necessary to assess whether previous results are context specific, or if they transcend certain contexts (Eden, 2004). Testing a theory or model across a variety of contexts can therefore contribute to theory confirmation, extension and/or development of a new theory (Aguinis, Pierce, Bosco, Dalton & Dalton, 2011). Following on from the proposed model and research agenda presented in the first study, the second study sought to test the main assumptions of this model using a sample of 200 employees with exposure to an array of lean manufacturing practices. Context has a significant influence on both job roles (and their resultant job design) and the relationships between job design features and various outcomes (Morgeson, Dierdorff & Hmurovic, 2010). Therefore, it was important to select job characteristics relevant to both lean manufacturing and to this individual group of workers. The specific job resources and demands relevant to the lean context were selected following their identification in the first study and via exploratory data collection with employees within the case site (attendance at lean workshops and informal group discussions). These additional characteristics of lean job design were considered as part of the 'discrete context' within the organisation, which acted as levers in shaping employees' attitudes and behaviour (Johns, 2006, p. 391). Once the relevant job characteristics had been selected for inclusion, a survey was administered in 2011 to a sample of 200 employees from one production unit at an off-site training day using the paper and pen method and via email for the remaining units. Data from Study 2 was analysed using (moderated) structural equation modelling (SEM) with the Mplus statistical package (version 6.12: Muthén & Muthén, 1998-2010).

1.4.1.3 Theory Expansion. Despite the value of testing both motivational and health-impairment processes using a between-person design, emerging evidence in the field demonstrates that employee well-being is a dynamic and continuous process which often takes place over shorter periods of time (Sonnentag et al., 2010; Xanthopoulou, Bakker & Ilies, 2010). Short term variations in job characteristics have also been associated with fluctuations in employee outcomes including work engagement, work-family facilitation and work-family conflict (Butler, Grzywacz, Bass & Linney, 2005; Petrou et al., 2012). Despite this, previous studies addressing the well-being implications of lean manufacturing for employees (including Study 2 in this thesis) have exclusively focused on relationships at the between-person level, where job characteristics and employee outcomes are considered to be relatively stable (e.g. Jackson & Mullarkey, 2000; Parker, 2003). Research in this area has also focused on the implications of job redesign specifically undertaken by management, despite the growing consensus that jobs can also be modified or restructured by employees themselves (Grant & Parker, 2009; Oldham & Hackman, 2010). Considering these issues, the third study sought to examine the temporal relationships between job design resultant from lean manufacturing, employee job crafting and work engagement using a within-person approach. The use of a diary study allowed the research to capture "life as it is lived" (Bolger, Davis & Rafaeli, 2003, p. 597) in lean organisations. In doing so it was possible to examine why employees who are generally happy working in this environment, may not be happy every day due to changes in their exposure to a selection of lean-specific job characteristics. This approach also facilitated measurements closer to the actual experience of participants and therefore minimised the bias of retrospective recall (Bolger et al., 2003; Ohly, Sonnentag, Niessen & Zapf, 2010). Variables for inclusion in the dairy study (which are outlined in section 4.5.3) were selected on the basis of their relevance to lean manufacturing, their likelihood to vary on a daily basis and their predictive validity at the general level (i.e. results of Study 2). In a diary study the number of items should be minimal in order to avoid respondent fatigue or frustration (Reis & Gable, 2000). Consequently, a minimum of three items were selected from the original scales based on face validity and from the items which demonstrated the highest factor loadings on their respective factors in Study 2. Data from Study 3 was analysed using multilevel structural equation modelling (ML-SEM) using the Mplus statistical package (version 6.12: Muthén & Muthén, 1998-2010).

1.4.2 Research Context

The research took place in an Irish subsidiary of a large European multinational organisation which operates as part of the manufacturing arm of their pharmaceutical division and employs approximately 390 people. The case site manufactures the active ingredients and intermediates that go on to the final stage of manufacturing in one of their 25 drug product plants worldwide. While pharmaceutical manufacturers traditionally focused on the productivity and optimisation of R&D in the 1980s and 1990s, cost pressures on supply chains have grown rapidly in recent years due to market rivalry for new, safe and effective drugs with short production times (Behr et al., 2004; Gebauer, Kickuth & Friedli, 2009; Melton, 2005). The market demand for variety in pharmaceutical produce requires greater flexibility, smaller orders and a more varied mix of products within the manufacturing process (Gilmore & Smith, 1996). In response to these demands, the adoption of lean manufacturing has become widespread for pharmaceutical manufacturers (Gebauer et al., 2009).

Studies which examine configurations of practices relating to systems such as high-performance HR or lean manufacturing require detailed descriptions of settings and their distinct features in order to identify the effects that derive from these configurations (Rousseau & Fried, 2001). In addition, as configurations of lean practices are difficult to imitate (Shah & Ward, 2007), individual organisations and sites within those organisations will vary widely in their adoption. In order to gain a deeper understanding of how job design within this context impacts employee outcomes, it is therefore necessary to understand the conditions pertaining to lean manufacturing within the wider organisational context. Lean manufacturing was first introduced to the organisation and this particular site in 2003 with the goal of sustainable reductions in cycle time, inventories, and costs. The level of lean implementation on site was determined for the present research using a lean assessment survey (Shah & Ward, 2007). The survey (see Appendix D) was completed by the Head of Automation, whereby the level of implementation for each practice ranged on a scale from 1 (No Implementation) to 5 (Complete Implementation). An interview was also conducted with the Head of Automation in order to discuss the organisation's adoption of these practices in more detail. All practices (see Table 3.1) had a minimum of 3 (some implementation) with extensive or complete implementation in most areas including supplier feedback and development, customer involvement, set-up time reduction, preventative equipment maintenance, employee involvement and continuous flow. Items relating to visual process management, where visual displays are used around the shopfloor to present the progress of the process, were also included in the assessment following recommendation from the authors of the scale (Shah & Ward, 2007). This practice was also rated as extensively implemented on site. Although the level of lean implementation on site was not rated independently (by an external expert) for analytical purposes, this evaluation strengthens the interpretation of the studies' findings as they are situated in a context representative of extensive lean implementation.

In addition, interviews with members of the HR team (HR manager and training manager) were carried out in order to understand the strategies used to align the organisational culture with lean manufacturing principles. This information revealed a number of important insights. A flat and cross-functional organisational structure with only three hierarchical layers (site head, production unit head, operating team member) was introduced to replace the previous structure of six layers. Traditionally departments or functions were silo-based and utilised a ‘chain of command' hierarchy. However following the introduction of lean manufacturing, all functions (e.g. manufacturing, quality assurance and control, maintenance etc.) were integrated within a larger ‘process unit’ which operates either one or a number of manufacturing lines as a single cross-functional and self-directed team. HR practices such as training, performance and reward management were also redesigned accordingly so that they would complement the flattened production team structure (e.g. cross-functional training, 360 degree performance feedback, team-level performance benefits). These efforts reflect a configurational approach to HR within the organisation whereby the HR practices were adapted to achieve vertical fit between the HR system and the organisation’s strategic decisions regarding lean implementation (Wright & McMahan, 1992).

1.4.3 Data Analysis

The use of the statistical package Mplus (version 6.12; Muthén & Muthén, 1998-2010) in Studies 2 and 3 facilitated the testing of the proposed hypotheses. Specifically, structural equation modelling (SEM), moderated SEM using latent variables (MSEM), multi-level SEM (ML-SEM) and cross-level interactions within ML-SEM were used. The advantages of SEM over regression analysis include its ability to model latent variables, correct for measurement error, specify errors and their covariance structures and estimate entire theories simultaneously (Henseler, 2012; Oke, Ogunsami & Ogunlana, 2012). As missing data was a potential issue for both studies, all analysis used the maximum likelihood method of estimation which estimates a likelihood function for each individual based on the present variables so that all available data can be used (Bollen, 1989). The adoption of SEM to test the hypotheses in Study 2 allowed the simultaneous examination of both motivational and health-impairment processes within the lean context, rather than examining them separately. Prior to testing the hypotheses, confirmatory factor analysis (CFA) determined whether job resources and job demands could be differentiated and also whether work engagement and exhaustion could be differentiated within the model.

MSEM was used to test the interaction between the latent variables (job resources and job demands) in Study 2. Indictors for the latent interaction terms were created using the factor loadings calculated from the products of the indicators for the predictor and moderator variables (Klein & Moosbrugger, 2000). This approach is based on the analysis of the multivariate distribution of the joint indicator path which takes into account the specific type of non-normality implied by latent interactions. Contrary to regression analyses which compute a scale by creating a sum index of several manifest variables, latent interaction modelling in SEM controls for different kinds of random and non-random measurement errors (Bollen, 1989; Steinmetz, Davidov & Schmidt, 2011). Therefore, MSEM minimises the contamination of independent variables by measurement error encountered when testing interactions using the sum index of observed variables, and provides accurate estimates of the true interaction effects (Moulder & Algina, 2002). The use of MSEM in Study 2 allowed the examination of the interplay between latent job resources (as indicated by training, feedback and boundary control) and job demands (as indicated by production pace, task interdependency, problem solving and accountability) rather than examining the individual interactions between all indicators one by one, easing the interpretation of results.

The use of multi-level structural equation modelling (ML-SEM) in Study 3 combines SEM with the analysis of hierarchical data and facilitates the development of SEM models at each level of nesting for clustered data (Kaplan & Elliot, 1997; Mehta & Neale, 2005; Muthén & Satorra, 1995). An advantage of this type of analysis is the use of full-information maximum likelihood estimation (FIML), allowing for missing data which includes an unequal number of observations per day and an unequal number of days per individual (Mehta & Neale, 2005). Therefore, all employees who completed the general survey and at least one daily survey were included in the ML-SEM analysis. The testing of cross-level interactions using ML-SEM also has a number of advantages over the more commonly used moderated multiple regression approach. These include the ability to examine the influences of continuous higher-level variables on lower-level outcomes rather than forcing the situation to be conceptualised as categorical differences (Aguinis, Gottfredson & Culpepper, 2013). To test this interaction, the random slopes of the job design-job crafting relationship (e.g. skill utilisation-seeking resources) were regressed on general level task interdependency. Level 1 predictor variables were centered around the person mean to improve the interpretation of both the direct and cross-level interaction effects in Study 3. This ensured that the between-person differences were removed in the analysis, therefore leaving only a "pure" estimate of the pooled within-cluster regression coefficient (Enders & Tofighi, 2007). Using ML-SEM the author was able to model paths between day-level variables at the within-level while also controlling for individual baseline levels of work engagement, job roles and tenure. This approach greatly assisted in broadening our understanding of the dynamic antecedents and consequences of job crafting in employees' daily experience of work under lean manufacturing. The use of ML-SEM to test the proposed cross-level interaction further permitted the novel examination of the interplay between dynamic (skill utilisation and problem solving) and stable (task interdependency) job characteristics as antecedents of daily job crafting.

1.5. Conclusion

In this chapter, the theoretical background to lean manufacturing and the debate surrounding the quality of working life for employees within this context was outlined. The overall research objective and specific research questions to be addressed by the three studies were also presented. Finally, the development of the research from model design in Study 1 to data collection and analysis in Studies 2 and 3 was presented in addition to the organisational context within which the empirical studies took place. The three studies which follow examine the processes through which lean-specific job characteristics impact the quality of working life for employees from a conceptual, stable and temporal standpoint. In the final discussion chapter which follows from the three studies, the findings and contributions of these studies will be evaluated in light of the overall research questions outlined above. The limitations of the overall research and a number of recommendations for future research and management practice will also be presented.

Chapter Two

Job Design under Lean Manufacturing and its Impact on Employee Outcomes

Based on: Cullinane, S. J., Bosak, J., Flood, P. C., & Demerouti, E. (2013). Job design under lean manufacturing and its impact on employee outcomes. *Organizational Psychology Review*, *3*, 44-61.

2.1 Introduction

Is lean manufacturing good or bad for employees? The past two decades have seen this question debated time and time again by its advocates and critics. However, evidence from both sides is largely anecdotal and any conclusions that can be drawn are speculative (de Treville & Antonakis, 2006). Lean manufacturing is a multidimensional approach to manufacturing which encompasses a wide variety of management practices within an integrated system dedicated to minimising waste (Shah & Ward, 2003). Early research examining lean manufacturing has argued that it leads to work intensification (Delbridge et al., 1992) and represents 'management by stress' (Delbridge & Turnbull, 1992; Parker & Slaughter, 1988). Other research has suggested that if lean systems were implemented effectively, employees would work 'smarter, not harder' and experience a decrease in work-related stress (Wickens, 1995; Womack et al., 1990). Given these claims it is striking how little empirically grounded research exists to date to answer this question (Anderson-Connolly et al., 2002; Parker, 2003). Studies which have empirically assessed the implications of lean manufacturing for employees have yielded contradictory findings which either demonstrate solely negative outcomes (Parker, 2003; Sprigg & Jackson, 2006) or contingent outcomes where improved well-being is dependent on specific management practices (Anderson-Connolly et al., 2002; Conti et al., 2006; Jackson & Mullarkey, 2000). However, no applicable model has been identified to date which captures the complexity of job design under lean manufacturing despite attempts using models such as the JD-C model (Karasek, 1979) and the JCM (Hackman & Oldham, 1976).

This chapter proposes a framework of job design which represents a stable model of operations within a lean context using an integration of the JD-R model (Demerouti et al., 2001) and current versions of the JCM (Campion et al., 2005; Morgeson & Humphrey, 2008).

The use of the JD-R model accommodates claims made by both advocates and critics as it incorporates dual health-impairment and motivational processes. The JCM captures the various levels of job design (task, knowledge, and social) under lean manufacturing and the mechanisms through which it impacts a range of psychosocial outcomes. The JCM and JD-R frameworks are adapted and integrated to demonstrate the long term everyday implications of lean manufacturing for job design, and in doing so, show how jobs designed according to lean manufacturing principles influence motivational and health-related outcomes. As both financial and non-financial organisational outcomes of lean manufacturing such as profit, reduced inventory, reduced manufacture times, increased quality, increased flexibility and increased customer satisfaction have been well documented (Ahls, 2001; Alavi, 2003; Emiliani, 2001; Fullerton & Wempe, 2009; Womack & Jones, 1994), the present study focuses on the more neglected topic of psychosocial outcomes at the employee level. A research agenda is created to improve our understanding of the employee experience of lean work and to promote the creation of contextualised job design models. A number of practical implications for the configuration of jobs under lean manufacturing are outlined.

2.2 What is Lean Manufacturing?

The focus of lean manufacturing in recent years has broadened beyond shopfloor tools to the lean principles which incorporate the notion of value and waste elimination into the production system (Womack & Jones, 1994). Increased pressure on organisations to remain competitive in terms of their product cost, service and quality, has led to the establishment of lean manufacturing as one of the most widely used production systems, as its positive impact on organisational performance and competitive advantage has been widely demonstrated (Brown et al., 2006; Cua et al., 2001; Fullerton & Wempe, 2009). As a result it has now extended beyond manufacturing into the service industry (Abdi et al., 2006), the public sector (Kollberg et al., 2006) and knowledge work (Staats et al., 2011).

To date the precise meaning of the term lean manufacturing has been contested. It has more recently been described as a multidimensional approach to manufacturing which encompasses a wide variety of management practices within an integrated socio-technical system dedicated to minimising waste (Shah & Ward, 2003; 2007). The inclusion of the terms 'socio' and 'technical' support those who claim that it needs to be regarded as a 'culture' which integrates both its technical tools and management philosophies (Birdi et al., 2008; de Menezes et al., 2010). Its technical tools are used to reduce waste in human effort, inventory, time to market and manufacturing space (see Table 2.1 for definitions). As a management philosophy lean manufacturing is intended to change how people work by giving them more challenging jobs, greater responsibility and an opportunity to work in teams (MacDuffie & Pil, 1995; Womack et al., 1990). Therefore, within a lean culture the focus switches from "potential efficient bundles of practices to this unobserved philosophy or management approach" (de Menezes et al., 2010, p.13). In the examination of lean manufacturing and its well-being outcomes, its treatment as either a selection of purely technical practices or alternatively a socio-technical culture has yielded contradictory findings. Those approaches which have addressed individual lean practices such as performance monitoring and moving assembly lines, and their isolated effects have primarily concluded that lean manufacturing is damaging for employees due to the deterioration of job characteristics necessary for job enrichment such as autonomy and skill utilisation (Parker, 2003; Sprigg & Jackson, 2006). Alternatively those approaches which have addressed lean manufacturing as an integrated set of technical and human practices have concluded that it has the potential to be both empowering and exploitative (Anderson-Connolly et al., 2002;

Conti et al., 2006; Jackson & Mullarkey, 2000). However, no applicable model of job design has been identified which incorporates these contingencies.

Table 2.1 Lean Manufacturing Practices Defined (Fullerton et al., 2003)

Practice	Definition
Focused factory	Centred around simplifying the organisational structure, reducing the numbers of products or processes, and minimising the complexities of physical constraints
Group technology	Collecting and organising common concepts, principles, problems, and tasks. It avoids unnecessary duplication through standardisation. It includes sequencing similar parts through the same machine and creating manufacturing cells for processing
Reduced setup times	Reduction of the time and costs involved in changing tooling and other aspects required in moving from producing one product to another. This reduces lot sizes and the need for buffer inventories
Total productive maintenance	Rigorous, regularly scheduled preventative maintenance and machine replacement programs. Operators are actively responsible for the maintenance of their machines
Multi-function employees	Extended training of employees on several different machines and in various tasks
Uniform workload	Reductions of the fluctuations of the daily workload through line balancing, level schedules, stable cycle rates, and market-paced final assembly rates
Kanban	A card or information system that is used to ‘pull’ the necessary parts into each operation as they are needed
JIT purchasing	A supplier participation and partnership program. Receiving just the right parts just when they are needed. Suppliers, lot sizes, and paperwork are reduced
Total quality control	Quality is established as the top priority of the production systems. Involvement in quality effort is required by all aspects of the organisation. Implementation of statistical quality control methods is an integral part of establishing both process and product quality
Quality circles	Small groups are formed from employees doing similar tasks. The groups are created to encourage employee participation in problem solving and decision making

2.3 Job Design under Lean Manufacturing

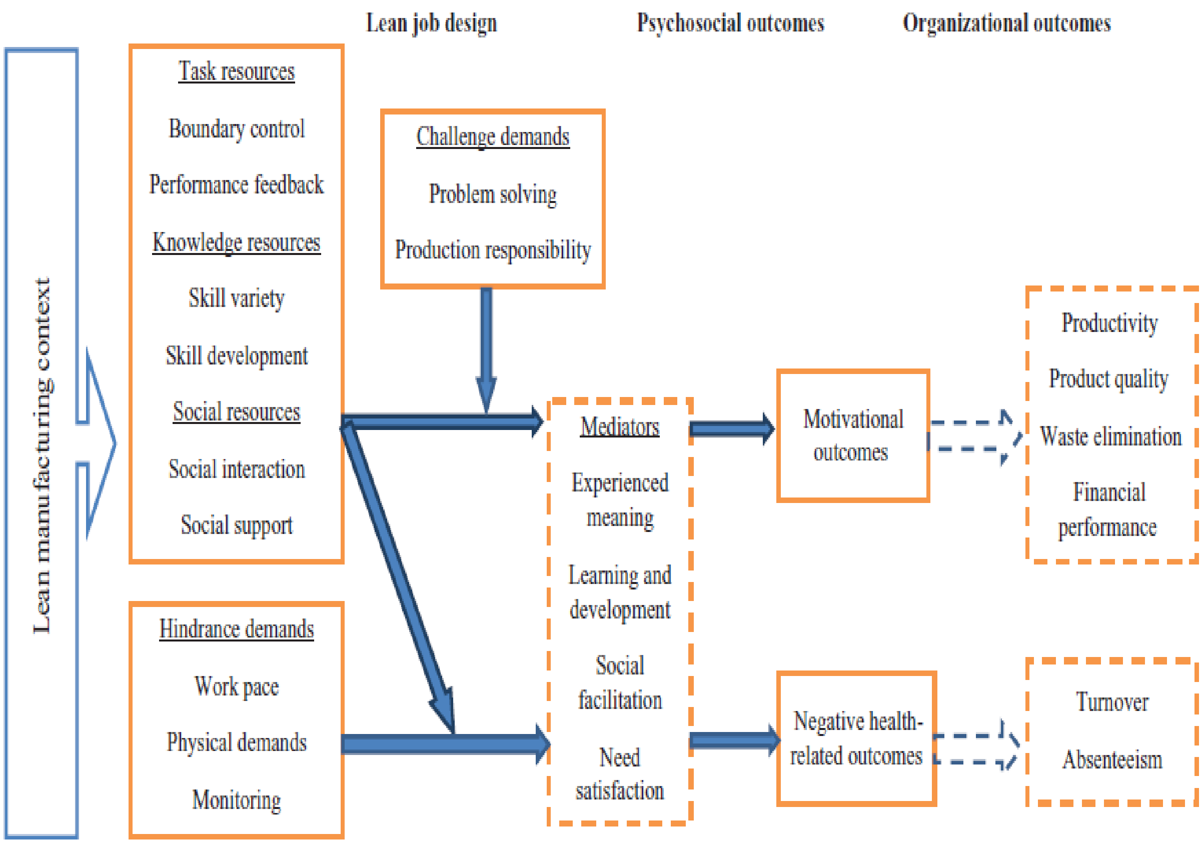
Until recently it had been accepted that within approaches to job design, there exists prominent trade-offs between the ‘mechanistic’ design, which is grounded in industrial engineering and oriented toward process simplification and efficiency, and the ‘motivational’ design, which is grounded in organisational psychology and oriented towards increasing employee satisfaction and intrinsic motivation. These trade-offs have also been acknowledged by critics of lean manufacturing who claim that its performance advantages are gained at the expense of employee welfare (Delbridge et al., 1992; Parker & Slaughter, 1988). Campion et al. (2005) have however identified a ‘synthesis’ approach to job design which minimises the trade-offs between these contrasting approaches. This interdisciplinary approach to job design specifies areas in which gains can be made by the motivational model without sacrificing the mechanistic model and vice versa (Morgeson & Campion, 2002). Campion et al. (2005) provide examples of the synthesis approach to job design which include Total Quality Management, reengineering and the socio-technical systems approach. The features associated with these management approaches such as continuous learning, cross-functional autonomous work teams and management by data are however now heavily associated with the aforementioned conceptualisation of lean manufacturing (Shah & Ward, 2003; 2007). Therefore a synthesis approach is necessary to capture these mechanistic and motivational aspects of jobs designed according to lean manufacturing systems.

The neglect of context in organisational behaviour research is a growing concern (Grant et al., 2010a; Rousseau & Fried, 2001) as it is frequently “controlled away” by researchers rather than assessing its impact empirically (Johns, 2006, p. 389). The lean context in particular brings to light the limitations and problems associated with context free job design models (de Treville & Antonakis, 2006). This is evident in the research addressing employee implications of lean manufacturing which tests these models using a predetermined set of job characteristics in a lean context, yielding unpredicted or non-significant findings. For example, the JD-C model (Karasek, 1979) was found to be limited when used in lean contexts in terms of its exclusion of important job characteristics and treatment of job control as a single construct (Anderson-Connolly et al., 2002; Conti et al., 2006). The JCM, as originally proposed by Hackman and Oldham (1976) is also incompatible with the lean context as it overlooks a number of potentially important independent variables by directing attention to theoretically specific factors (de Treville & Antonakis, 2006; Jackson et al., 1993; Wall & Martin, 1987).

The following section demonstrates how an integration of the JD-R model and updated interdisciplinary approaches to the JCM first allows us to contextualise the selection of job characteristics for lean manufacturing, and second to assess their impact on psychosocial outcomes. The JD-R model (Demerouti et al., 2001) moves beyond the JD-C proposition that the provision of control to employees would buffer the impact of job demands on stress and burnout. It focuses instead on both the interactive and independent effects of job demands and job resources, the theoretical and empirical differentiation of which is supported by the literature (Bakker & Demerouti, 2007; Crawford et al., 2010; Demerouti et al., 2001; Halbesleben, 2010). Therefore, although their resulting motivational and health-impairment processes are related, they are in fact psychologically different (Bakker & Demerouti, 2007; Schaufeli & Bakker, 2004). Interdisciplinary research has also aided the identification of additional job characteristics and outcomes within the JCM (Grant et al., 2010b; Morgeson & Humphrey, 2008). In utilising the proposed model (presented in Figure 2.1) both motivational and mechanistic approaches to job design are incorporated. This acknowledges that lean manufacturing can have both motivational and demanding implications for job design, which will determine psychosocial outcomes through both their direct effects and interaction with one another.

Figure 2.1 Model of Job Design under Lean Manufacturing and its Impact on Employee Psychosocial Outcomes

Note. The dotted lines are presented in section 2.6.1 Theoretical Implications



2.4 Lean Resources

The vital resources or 'supporting conditions' required by lean employees to carry out their tasks and cope with the interdependent nature of the work (Oliver & Wilkinson, 1992) are often overlooked in the discussion of everyday lean practices. The findings of previous studies which addressed well-being implications of lean manufacturing have identified a number of job characteristics which were negatively related to stress within a lean context. These characteristics include team working (Conti et al., 2006), skill utilisation (Sprigg & Jackson, 2006), autonomy (Anderson-Connolly et al., 2002), social climate (Jackson &

Mullarkey, 2000) and participation (Parker, 2003), and there is significant overlap between the studies in their findings. Within the JD-R model job resources refer to those physical, psychological, social or organisational aspects of the job that are either functional in achieving work goals, reducing job demands and the associated physiological and psychological costs, and stimulate personal growth, learning and development (Demerouti et al., 2001). These job resources set in motion a motivational process through which employees satisfy their basic needs for autonomy, competence and relatedness (Hakanen & Roodt, 2010; Mauno et al., 2007) and foster motivational outcomes such as engagement and commitment. However despite its differentiation between aspects of the job within the definition, most JD-R studies do not differentiate between physical, psychological, social or organisational resources therefore treating all resources in a similar fashion. Recent developments in job design research have however broadened the job characteristics of the JCM beyond the task level to also include social, contextual (Morgeson & Humphrey, 2008), knowledge and physical characteristics (Grant et al., 2010b). Using an integration of both approaches, the next section demonstrates how the task (control and performance feedback), knowledge (skill utilisation, variety and development) and social (interaction, support) resources associated with lean manufacturing principles influence motivational outcomes.

2.4.1 Task Resources.

2.4.1.1 Control. The role of control in lean manufacturing is one of the most complex and tested resources in terms of its actual existence at the employee level and its potential prediction of employee outcomes such as motivation and well-being (e.g. Delbridge et al., 2000; Jackson & Mullarkey, 2000). In terms of its existence, the lean context is designed to increase employee control and involvement in decision making through their participation in problem solving activities (Womack et al., 1990). This encouragement of worker control is intended to legitimise and value the inputs of employees which reverse the separation of conception and execution under mass production (Macduffie, 1995). However, despite the intentions of its design, this promotion of employee control has not been found to reflect the reality of lean manufacturing in studies which concluded that any redistribution of autonomy towards production operators is at best limited and at worst negative or non-existent (Delbridge et al., 2000). Many have even described the provision of control to employees or teams as a means of manipulating employees into exerting more effort in their work (Delbridge et al., 1992; Graham, 1995; Pruijt, 2003). Therefore a tension exists between the lean practices which encourage autonomy such as employee involvement (Shah & Ward, 2007), and those which inhibit autonomy such as statistical process control using predetermined production rates and eliminate discretion and judgment in the assembly of products (Conti & Warner, 1997).

Of the studies which examine the well-being outcomes of job design under lean manufacturing, some have examined control as a single factor (Anderson-Connolly et al., 2002; Parker, 2003) which is argued to be inappropriate in this context and therefore accounts for contradictory findings regarding the effects of lean manufacturing on well-being (de Treville & Antonakis, 2006). Others however have differentiated between different types of control such as timing, method and boundary (Jackson & Mullarkey, 2000; Sprigg & Jackson, 2006), or responsible and choice (de Treville & Antonakis, 2006). Research has demonstrated that although these dimensions are related to each other, they have unique predictive validity (Humphrey, Nahrgang & Morgeson, 2007). Both Sprigg and Jackson (2006) and Jackson and Mullarkey (2000) predicted that employees exposed to lean manufacturing experienced a decrease in both timing and method control which were supported with the exception of method control in one study where levels were similar in both lean and non-lean teams (Jackson & Mullarkey, 2000). However these authors also predicted and established an increase in boundary control for lean employees. This type of control refers to the extent to which operators are responsible for secondary activities previously associated with supervisory roles, which are completed in support of the primary operating tasks (e.g. machine maintenance, inspection, quality assurance etc.) (Wall et al., 1990). Similarly de Treville and Antonakis (2006) propose that although lean manufacturing decreases choice concerning procedure and timing it has the potential to increase responsible autonomy where employees actively participate in decision making. Based on both these predictions and empirical findings it is expected that under lean manufacturing employees can redefine their role boundaries to include more varied direct production tasks as well as indirect tasks in support of the production process (Wall et al., 1990).

Boundary control, in addition to general autonomy, has been found to have different effects across studies. For example, some studies found no effect of boundary control on job strain yet they found that when operators were given broader responsibilities and dealt directly with the majority of operating problems encountered they reported higher job satisfaction and reduced job pressure (Jackson & Mullarkey, 2000; Wall et al., 1990). A possible explanation for the independence of control and well-being in these studies is that employees in particular industries such as garment manufacturing have never expected to be offered significant autonomy (Jackson & Mullarkey, 2000) as they are accustomed to what is referred to as “specialist control” (Wall et al., 1990, p. 691). Mullarkey et al. (1995) found that increases in boundary control following implementation of product-based manufacturing and total quality practices were associated with increased levels of psychological well-being. More generally both Conti et al. (2006) and Anderson-Connolly et al. (2002) found support for the negative impact of autonomy on job strain, particularly in terms of participation in improvement activities. Context aside, Knight and Haslam (2010) found that employees who felt they had autonomy over their work space, an important aspect of boundary control, reported higher levels of psychological comfort and organisational identification. Autonomy in general also holds the highest significance above other resources in its prediction of well-being using the JD-R model (Halbesleben, 2010). Similarly, job design meta-analyses demonstrate autonomy as the most influential job characteristic in the JCM in its prediction of well-being, attitudinal and performance outcomes (Humphrey et al., 2007). It is therefore predicted that boundary control will be positively associated with motivational outcomes under lean manufacturing.

Proposition 1: Boundary control resultant from lean manufacturing leads to an increase in motivational outcomes

2.4.1.2 Performance Feedback. The lean system is designed to adapt quickly to small variations in demand and to reduce variability in its processes. In order to do so it creates a system where employees receive timely and highly visible feedback on current process quality, such as defect rate or machine breakdown frequency, using highly visible communication tools such as charts posted on the shop floor (Forza, 1996). Statistical process controls are fed by continuous data regarding process behaviour which serves to greatly influence product quality through the short and fast feedback loops to the operator from the process (Greller & Herold, 1975). The minimising of buffers in lean manufacturing also serves as a feedback mechanism regarding production problems where any discrepancies between the production target and actual performance are instantly made apparent (Schonberger, 1982). In a comparison of lean and non-lean plants, Forza (1996) found feedback practices to be more heavily utilised in lean organisations. Based on the above evidence lean manufacturing is expected to be associated with performance feedback due to practices such as statistical process control and visual management tools.

According to the JCM (Hackman & Oldham, 1976), feedback affects employee knowledge of results which, in addition to other characteristics, determines critical psychological states such as motivation and self-efficacy. Feedback plays an even more significant role in lean manufacturing than in traditional mass production as employees require direct and clear information regarding process performance in order to carry out their work activities (de Treville & Antonakis, 2006). Conti et al. (2006) note that although feedback reduces role ambiguity within the lean context through task and goal clarification, it is also a potentially stressful form of coercion for continuous performance improvements. It also, in its increase of individual and team accountability, has been argued to create a system where employees are essentially 'hung out to dry' (Niepce & Molleman, 1998) in terms of any discrepancies in their performance which can act as a source of strain (Delbridge & Lowe, 2002; Rinehart et al., 1997). However, upon testing the hypothesis that job stress might be positively related to feedback no evidence was found to support the latter argument (Conti et al., 2006). The authors attribute this to the increasing interdependency within lean teams which no longer facilitates the performance tracking of individual employees and therefore displayed feedback tends to be at a more aggregate level (Conti et al., 2006). Therefore, as the only evidence we are aware of shows that feedback is not predictive of stress under lean manufacturing, we can assume the probability of a positive effect particularly based upon its positive relationship with motivational outcomes such as work engagement within JD-R research (Schaufeli & Bakker, 2004; Schaufeli et al., 2009) in addition to job satisfaction and motivation within job design research (Humphrey et al., 2007).

Proposition 2: Performance feedback resultant from lean manufacturing leads to an increase in motivational outcomes

2.4.2 Knowledge Resources. The multi-skilling activities associated with lean manufacturing such as cross-training, job rotation, problem solving and participation in decision making are said to promote more skill variety than traditional work environments (Adler & Cole, 1993; Macduffie, 1995; Mullarkey et al., 1995; Womack et al., 1990). Lean manufacturing is designed to develop teaching and learning through unique relationships between managers, supervisors and employees with the aim of establishing a "learning bureaucracy" (Adler, 1990, p. 111). Within this "learning bureaucracy" supervisors and managers are instructed to avoid making decisions for their subordinates and to answer questions with questions in order to create implicit knowledge (Spear & Bowen, 1999). De Treville and Antonakis (2006) predicted that lean manufacturing is associated with employee skill variety where they participate in problem solving, receive training and rotate jobs. Sprigg and Jackson (2006) found no support for their hypothesised decrease in skill utilisation for those exposed to lean practices, while Parker (2003) found partial support for a similar hypothesis. Contrasting findings from Jackson and Mullarkey (2000), who examined teams using an array of lean practices, found that lean teams had a significantly higher level of skill utilisation than those using traditional batch methods of production. Overall these findings suggest that employees under lean manufacturing use a broader variety of skills through job rotation and cross-training and utilise their skills through problem solving activities over those using traditional manufacturing methods.

Some authors claim that by cross-training team members to perform a variety of tasks they can help each other to balance out workloads and solve production problems providing both resource and emotional support for its members (Conti & Gill, 1998). Its multi-skilling activities are, in reality, methods of encouraging employees to multitask to accommodate short production cycle-times (Rinehart et al., 1997). Conti et al. (2006) found no significance in the tested relationship between lean training and work-related stress whereas Anderson-

Connolly et al. (2002) found skilling (development and utilisation) to be positively related to stress for non-managers under lean manufacturing due to increased role ambiguity. Alternatively, they found it to be positively related to management satisfaction due to increased role challenge. These findings are inconsistent with assumptions of stress theorists who view training as a form of support which is highly significant in the alleviation of stress (Karasek & Theorell, 1990). However a number of other studies which took place in lean teams found skill utilisation to have a significantly negative effect on job-related strain, anxiety and depression (Jackson & Mullarkey, 2000; Parker, 2003; Sprigg & Jackson, 2006). Skill development and utilisation have also been linked to positive outcomes using the JD-R framework such as task enjoyment and organisational commitment (Bakker, van Veldhoven & Xanthopoulou, 2010). Similarly, within job design studies, 'knowledge' characteristics have also been found to predict positive outcomes such as job satisfaction (Morgeson & Humphrey, 2006). Considering the above evidence, the facilitation of skill variety and utilisation by lean manufacturing through activities such as job rotation and problem solving is predicted to lead to increased motivational outcomes.

Proposition 3: Skill variety and utilisation resultant from lean manufacturing lead to an increase in motivational outcomes

2.4.3 Social Resources. Social aspects of lean manufacturing tend to receive less attention than task characteristics in the prediction of well-being largely due to its exclusion from job design models such as the original versions of the JCM (Hackman & Oldham, 1976) and the JD-C model (Karasek, 1979). Conti and Gill (1998) propose that the teamwork element of lean manufacturing provides employees with the emotional support required to carry out their job. Its culture of team working, participation and involvement is believed to foster shared values that engender mutual trust and support (Mullarkey et al., 1995). Many critics of lean manufacturing, however, would describe its social climate as characterised by peer pressure and competitiveness (Delbridge & Turnbull, 1992; Rinehart et al., 1997). They argue that social tensions can develop when the entire team is held accountable for the errors or slack of specific members (Delbridge & Lowe, 2002; Mullarkey et al., 1995).

The empirical evidence needed to determine whether a positive social climate under lean manufacturing can be facilitated is scarce. The redesign of the shop floor under lean manufacturing into production cells increases the level of interdependence between employees and subsequently the level of social interaction. Social interaction with those outside the immediate team such as technical specialists also increases due to the broadening of operational roles (Jackson & Mullarkey, 2000). Mullarkey et al. (1995) found that the introduction of cellular manufacturing and JIT practices (producing in real time according to customer order), which brought all employees together within a single production cell, led to a significant increase in co-worker support and group cohesiveness. Similarly, Jackson and Mullarkey (2000) found that lean teams reported higher levels of social interaction and trust in co-workers than non-lean teams, although group cohesion was significantly lower for lean employees. Their explanation for this was that although lean employees are less isolated and therefore receive more support from their colleagues, they have more opportunity for arguments within these systems due to high levels of interdependency and subsequent lack of tolerance for those not pulling their weight. Based on existing knowledge of social climate in lean contexts, employees under lean manufacturing are predicted to experience increases in the level of social interaction and support due to the design of interdependent production cells on the shop floor.

As social interaction has become more pervasive and prominent in contemporary work organisations, the importance of social and relational characteristics within job design theory is becoming increasingly recognised (Fried, Grant, Levi, Hadani & Slowik, 2007; Grant & Parker, 2009; Morgeson & Humphrey, 2006; Oldham & Hackman, 2010). A recent meta-analysis by Humphrey et al. (2007) found that social characteristics were associated with performance, turnover and satisfaction beyond non-social job properties. Studies of lean manufacturing have similarly found that support (i.e. task support and team working) has a stronger impact on job stress under lean manufacturing than job control (Anderson-Connolly et al., 2002; Conti et al., 2006). However others found social climate, with the exception of group cohesion, to be a non-significant predictor of strain in the lean context yet a strong predictor of job satisfaction (Jackson & Mullarkey, 2000; Mullarkey et al., 1995). Context aside, social characteristics have been found to negatively impact well-being outcomes such as stress and positively impact organisational commitment and job satisfaction (Humphrey et al., 2007; Watson, 1988).

Proposition 4: Social interaction and support resultant from lean manufacturing lead to an increase in motivational outcomes

2.5 Lean Demands

Within the JD-R model job demands refer to those physical, psychological, organisational and social aspects of the job that require sustained physical/psychological effort or skills and therefore are associated with physical/psychological costs (Bakker & Demerouti, 2007). Studies carried out in a variety of occupations have confirmed that badly designed jobs or high job demands such as workload, emotional demands and work-home conflict exhaust employees’ mental and physical resources and therefore lead to the depletion of energy and subsequently to health problems (Bakker et al, 2005; Bakker et al., 2004; Bakker et al., 2008). There is no shortage of evidence to suggest that first, lean manufacturing is a demanding work environment, and second that these intensified work demands can result in the deterioration of employee health (Landsbergis et al., 1999). A common conclusion of early research carried out in automotive manufacturers is that the lean environment is characterised by standardised, short-cycled, heavily loaded jobs (Rinehart et al., 1997). Conti and Gill (1998) on the other hand argue that the implications for job demands are not predetermined and that "there is nothing inherent in the structure of lean manufacturing that requires the use of greater than normal pace and intensity level" (p. 163). The next section demonstrates how the demands associated with lean manufacturing which are perceived as hindrances and challenges influence employee health-related outcomes.

2.5.1 Hindrance demands

MacDuffie (1995) identified three primary demands of lean manufacturing for employees which include 'doing work', 'thinking work', and 'team work'. The 'doing work' is similar to that of traditional manufacturing regimes where manual effort is difficult and demanding due to the use of moving assembly lines and narrow divisions of labor. The speed and volume of work is further accompanied by pressure on employees to monitor their processes which increases when operators are required to mind multiple machines, especially when such activities are tied closely to machine cycle-time (Jackson & Mullarkey, 2000). Many of the studies which have compared lean and non-lean employees have concluded that the former have a higher workload in terms of production pace and monitoring pressures (Jackson & Mullarkey, 2000; Sprigg & Jackson, 2006) whereas no empirical study, to the author's knowledge, has either predicted or found the opposite. Most of these studies found work intensity to be the most harmful aspect of lean manufacturing in terms of its effects on negative outcomes such as strain (Anderson-Connolly et al., 2002; Conti et al., 2006; Jackson & Mullarkey, 2000; Parker, 2003).

Although research in the area of job design has previously examined the health-related outcomes of physical demands and working conditions (Campion & McClelland, 1991; Edwards, Scully & Brtek, 1999), these ‘doing’ characteristics were predominantly excluded from job design models until recently (Grant et al., 2010b; Morgeson & Humphrey, 2008). This inclusion of demanding work characteristics further reflects the increased uptake of multidisciplinary approaches to job design which integrate mechanistic and motivational characteristics (Campion et al., 2005). Meta-analytic results demonstrate that job satisfaction is positively related to working conditions and negatively related to physical demands, with the opposite effects for strain (Humphrey et al., 2007). In terms of evidence within the occupational health literature, there is wide consensus that increased work pace is associated with health problems (Bakker et al., 2005; Bakker et al., 2004; Bakker et al., 2008). Although recent developments of the JD-R model have found workload to strengthen the motivational potential of job resources (Bakker et al., 2007), this is restricted to qualitative workload as opposed to the quantitative workload associated with lean manufacturing and production work in general. Hindrance demands have been found to trigger negative emotions and cognitions which result in passive, emotion-focused coping styles reflected in decreased engagement (Crawford et al., 2010). Using the JD-R model, studies have demonstrated that this health-impairment process is buffered by the provision of job resources such as control, social support and feedback (Bakker et al., 2005; Xanthopoulou et al., 2007). Therefore, based upon the evidence presented, hindrance demands associated with lean manufacturing, which include work pace, physical demands and monitoring pressure, are expected to increase negative health-related outcomes such as exhaustion. Furthermore, this health-impairment process will be weakened by the existence of job resources.

Proposition 5a: Work pace, physical demands and monitoring pressure resultant from lean manufacturing leads to an increase in negative health-related outcomes

Proposition 5b: The positive relationship between hindrance demands and negative health-related outcomes is buffered by the provision of job resources

2.5.2 Challenge demands

In contrast to 'doing' work, MacDuffie (1995) argues that the demands which are derived from continuous improvement programs (i.e. 'thinking work' and 'team work') are quite different to that of mass production methods. These demands require employees to have a broader contextual knowledge of the production tasks and link this knowledge to the processes to which they are assigned. Therefore lean manufacturing should result in a higher degree of integration between conceptual activity and production tasks (MacDuffie & Pil, 1997). These types of demands, where employees are under pressure to use their tacit knowledge to maintain the interdependent, repetitive flow of production, are described by Conti and Gill (1998) as 'psychological demands' or by Wall et al. (1990) as 'cognitive demands'.

Under lean manufacturing, standardised production processes can only occur when operators are responsible for anticipating and preventing problems that could disrupt output (Womack et al., 1990). Delbridge et al. (2000) in their comparison of over 70 companies using lean and non-lean methods found that the majority of problem solving activities took place within the production team where operators were responsible for improvement activities. However, these authors note that increases in responsibility within lean teams are often not accompanied by the necessary level of autonomy to execute decisions. MacDuffie and Pil (1997) similarly found that employees under lean manufacturing are responsible for decision making and problem solving processes in order to deal with uncertainty and variability in the quality of raw materials, human performance and machine efficiency. In traditional manufacturing systems these demands were primarily requirements posed by the supervisor. Jackson and Mullarkey (2000) also found that the level of production responsibility, which refers to the degree to which their alertness and behaviour can prevent costly disruption to production and machinery (Jackson et al., 1993; Wall, Jackson & Mullarkey, 1995), was greater in lean teams than non-lean teams. This was subsequently found to predict job satisfaction yet had a non-significant relationship with job strain.

The differentiations between the ‘doing’ and ‘thinking’ work in lean manufacturing are similar to recent differentiations made between hindrance demands and challenge demands within the JD-R model (Crawford et al., 2010; Van den Broeck et al., 2010). The ‘thinking’ demands such as problem solving and information processing, which are also more recent additions to the JCM, have limited empirical evidence linking them to well-being outcomes yet are predicted to have both demanding and satisfying attributes (Morgeson & Humphrey, 2008). Recent advancements of the JD-R model also demonstrate that this type of demand differs in its relationship with positive outcomes to that of hindrance demands. For example, challenge demands like responsibility have been found to predict positive outcomes such as work engagement by triggering positive emotions and cognitions that result in active, problem-focused coping styles (Crawford et al., 2010; Van den Broeck et al., 2010). However, in order to enrich jobs these cognitive demands also require a minimal level of resources such as control to cope effectively (Karasek & Theorell, 1990). In light of the above findings, these authors predict that challenge demands have a stronger role in their interaction with resources in the relationship with negative health-related outcomes than their direct effect.

Proposition 6: Problem solving and production responsibility resultant from lean manufacturing strengthens the relationship between lean resources and motivational outcomes.

2.6 Future Directions and Conclusions

2.6.1 Theoretical Implications

This chapter demonstrates how jobs designed according to lean manufacturing principles influence employee motivational and health-related outcomes. In doing so, lean manufacturing is proposed to influence job design first in the form of increased task (boundary control and performance feedback), knowledge (skill utilisation and variety) and social (social interaction and support) resources, which in turn are positively associated with motivational outcomes. Second, lean manufacturing is also proposed to influence job design in the form of increased job demands. Of these demands the hindrance demands (work pace, physical demands and monitoring responsibility) predict negative health-related outcomes, and challenging demands (production responsibility and problem solving) strengthen the relationship between job resources and motivational outcomes. These propositions imply that lean manufacturing is simultaneously a highly demanding and highly resourceful work environment. The design of jobs which are equally efficient and motivational under lean manufacturing, such as that presented by the synthesis approach to job design which minimised the trade-off between mechanistic and motivational job design (Campion et al., 2005), is the primary implication for future research.

As previously highlighted, the neglect of context has been a significant shortcoming of job design research (Parker et al., 2001; Rousseau & Fried, 2001). This study demonstrates the fundamental influence of context in determining job characteristics which impact employee psychosocial outcomes. In ignoring the contextual issues associated with lean manufacturing, or alternative contexts, we inhibit the potential interpretations of our research findings. Recommended methods to contextualise research include comparative, cross-level research or qualitative methods which provide rich description of the context under examination (Johns, 2006; Rousseau & Fried, 2001). Therefore, contexts such as lean manufacturing can be examined with respect to their individual level outcomes using either multi-level or comparative methods, or rich case studies utilising triangulated methods. Additional analysis techniques more sensitive to the distributional properties of data (e.g. variances, distribution shapes, degrees of within-unit agreement, etc.) are also recommended as superior methods of attending to context than simply addressing means (Johns, 2006). This study demonstrates how contingent models of job design can be created to more accurately fit a particular organisational context. This creation of a contingent job design model is not limited to lean manufacturing but lends itself to the study of different organisational structures, work relationships, environmental conditions and/or management goals. Therefore, contextual consideration is strongly encouraged, not only when assessing the impact of lean manufacturing at shop floor level, but in the realm of job design more generally. The model outlined in this chapter which integrates the JD-R model and the JCM provides a clear example of how this can be achieved for alternative settings or phenomena.

Context can also act as a moderator in the relationship between work design and outcomes which can occur across different levels of analysis (Morgeson et al., 2010). The inclusion of contextual considerations termed as ‘omnibus’ (Johns, 2006) such as the size and type of the company examined, length of lean manufacturing use, pre-existing work design, and implementation methods as potential moderators in the job design/health-related outcome relationship is strongly recommended. Parker (2003) noted how these contingency factors account for the same phenomenon (i.e. lean manufacturing) to differ in its effect on job characteristics. The length of lean usage is a particularly evident contingency factor as Conti et al. (2006) found increases in stress during initial implementation, a middle stage where stress levels off until it reaches a modulation point, and a further stage where increased implementation is associated with decreased stress. Therefore caution must be taken when examining job design shortly after lean implementation as complications relating to any period of organisational change will impact the relationship between job design and outcomes and subsequently limit the interpretation of findings.

While this study limits itself to the psychosocial outcomes of job design under lean manufacturing, there is also need for future research to examine the implications of this job design for organisational outcomes such as productivity, turnover, absenteeism and financial performance. JD-R studies have demonstrated how the good health of an employee facilitates performance at the organisational level as employees who create their own resources are better able to deal with their job demands and to achieve their work goals (Bakker & Demerouti, 2007; Hakanen, 2009; Salanova, Agut & Peiro, 2005; Salanova & Schaufeli, 2008). Similarly, job design research has found evidence for the relationship between job characteristics, such as those outlined in the above propositions, and organisational outcomes such as worker compensation (Morgeson & Humphrey, 2006), training demands (Campion, 1988), skill requirements (Capelli & Rogovsky, 1994) and organisational performance (Ketchen et al., 1997). Lean manufacturing has also been repeatedly associated with improved organisational performance and competitive advantage (Brown et al., 2006; Cua et al., 2001; Fullerton & Wempe, 2009). Critics of lean manufacturing however argue that its performance advantages can only be achieved through stressful work practices (Bruno & Jordan, 2002; Lewchuck, Stewart & Yates, 2001). Evidence to the contrary demonstrates that stressful practices were not necessary to achieve the performance benefits of a lean system as Conti and colleagues (2006) found no statistical significance in the correlations between reported improvement in productivity, quality and delivery and average stress levels within individual sites. The model outlined in this chapter allows us to envisage the relationship between lean manufacturing and performance through the process of job enrichment in contrast to job enlargement (Campion et al., 2005), a relationship which warrants further investigation.

A number of additional job characteristics beyond those developed within the above propositions could also be associated with lean manufacturing. For example, as jobs under lean manufacturing are multi-functional in nature (Adler & Cole, 1993; Macduffie, 1995; Womack et al., 1990), resources such as task identity (the degree to which a job requires completion of a whole and identifiable piece of work; Hackman & Oldham, 1976) and demands such as equipment use (variety and complexity of the technology and equipment used in a job; Morgeson & Humphrey, 2006) could also be evident. In addition, the JCM identifies the potential mediating mechanisms which explain the processes through which job characteristics influence outcomes which include experienced meaningfulness, felt responsibility and knowledge of results (Hackman & Oldman, 1976). These mechanisms have remained within most recent job design models with the inclusion of additional potential mediators such as learning and development (Parker & Wall, 1998; Wall, Jackson & Davids, 1992) and social facilitation (Morgeson & Humphrey, 2008). Recent studies on the JD-R model also suggest that satisfaction of basic psychological needs (i.e. need for autonomy, competence and relatedness) represent a mediator between job demands and resources on the one hand and motivational and health-related outcomes (Van den Broeck et al., 2008). Additional mediating processes have also been proposed in updated versions of the JCM such as skill utilisation (Morgeson & Humphrey, 2008), goal generation and striving (Parker & Ohly, 2008), psychological empowerment (Thomas & Velthouse, 1990) and role-breadth self-efficacy (Parker, 2000). Therefore, in addition to empirically examining those outlined in this chapter, future research should identify additional characteristics of jobs designed according to lean manufacturing principles and the mediating mechanisms through which they promote positive outcomes for employees and organisations.

2.6.2 Practical Implications

The theoretical framework presented in this chapter for understanding how job design under lean manufacturing impacts employee psychosocial outcomes has a number of implications to guide current practitioners and future implementers. The most pressing issue, as presented within this model, is the provision of job resources in lean work. The demands presented above, such as increased production pace and responsibility, are inherent aspects of lean manufacturing. Therefore their impact on employee outcomes is dependent upon the provision of resources by management within the company. This would involve for example the provision of boundary control to shop floor operators by allowing them to carry out their own quality inspection, train one another and schedule their own work. This form of empowerment also stands out as the most likely resource to predict company performance (Birdi et al., 2008). Providing cross-functional training and job rotation would also develop operator skills, allowing them to cope with increased problem solving requirements (de Treville & Antonakis, 2006). To promote positive employee outcomes, these acquired skills must be utilised by management by allowing shop floor employees to participate in decision making related to the production process. In terms of performance feedback, much of the feedback to employees within lean manufacturing comes from the job or process itself through statistical process controls. However, management are nonetheless responsible for ensuring that additional feedback either in the form of visual management tools and charts on the shop floor or verbal feedback is timely, constructive and provided at the aggregated team level to avoid the development of a ‘blame’ culture. Therefore, through the provision of such resources, management can minimise the harmful effects of hindrance demands such as workload and pace, and optimise the effects of challenge demands such as increased responsibility to enrich jobs on their shop floor.

2.7 Conclusion

Most of the previous research in this area has either assessed the implications of individual lean practices in isolation, used auto-manufacturer case study findings without statistical validity to generalise the effects of its practices, or used job design models which were rigid in their selection of job characteristics. In contrast, this study emphasises the importance of understanding lean manufacturing as a culture which has several implications for job design and subsequent health-related outcomes at the employee level. In the extended use of the JD-R model and the JCM, the specific demands inherent in lean manufacturing and the necessary resources required to facilitate these demands were also identified. The processes, both dual and interactive, between these lean demands and resources and employee health-related outcomes are proposed according to the findings of previous research in the areas of both job design and occupational health. The resulting model (Figure 2.1) depicts both the potential health-impairing and motivational processes inherent in lean manufacturing. The model provides guidance to practitioners of lean manufacturing and additionally invites a body of research to investigate how jobs can be enriched within lean manufacturing organisations. On a final note, this study has attempted to prompt a shift in both the academic and practitioner perspective of lean manufacturing from being a system of ‘management by stress’ (Delbridge et al., 1992; Parker & Slaughter, 1988) in which performance advantages are gained at the expense of employee health, to that of one which has the potential to enhance both organisational performance (e.g. waste reduction, quality improvements, etc.) and the quality of working life for employees through simple job redesign. Further research addressing lean manufacturing from this holistic angle and establishing statistical evidence representative of the current, multi-industry lean context is advisable.

Following on from the proposed model and research agenda presented in this chapter, the next chapter presents a study which seeks to test the main assumptions of this model using a sample of 200 employees with exposure to extensive lean implementation. Specifically, the next chapter examines the direct and interactive effects of lean-specific job resources and lean-specific job demands in predicting motivational (work engagement) and negative health-related (exhaustion) outcomes for employees.

Chapter Three

Job Design under Lean Manufacturing and the Quality of Working-Life: a Job Demands and Resources Perspective

Based on: Cullinane, S. J., Bosak, J., Flood, P. C., & Demerouti, E. (under review). Job Design under Lean Manufacturing and the Quality of Working-Life: a Job Demands and Resources Perspective.

3.1 Introduction

Lean manufacturing is a multidimensional approach to manufacturing which encompasses a wide variety of management practices within an integrated system dedicated to minimising waste (Shah & Ward, 2003; 2007). The question as to whether working conditions under lean manufacturing are damaging or beneficial for employee health and well-being has been a hotly debated topic for many years, and forms the backdrop to the investigation reported in this chapter. Reviews of existing studies mainly report negative effects on both working conditions and subsequent health, however, these effects are primarily evident for manual work with low levels of complexity (Hasle et al., 2012; Landsbergis et al., 1999). An increasing number of studies have found lean manufacturing to have a mixture of positive and negative effects on working conditions and well-being (Anderson-Connolly et al., 2002; Conti et al., 2006; Godard, 2001; Jackson & Mullarkey, 2000; Seppällä & Klemola, 2004), and some demonstrate that employees in jobs with higher complexity experienced job improvements such as increased participation in decision making and improved completeness (Parker, 2003; Schouteten & Benders 2004). Therefore, based on the existing contradictory evidence, "an unambiguous negative or causal effect of lean cannot be established" and there is need for a more open and flexible model which accounts for both positive and negative effects (Hasle et al., 2012, p. 845).

One contributor to the inconsistencies in evidence is the lack of an applicable model of job design which captures the complex socio-technical nature of lean manufacturing. Models such as the JD-C model (Karasek 1979) and the JCM (Hackman & Oldham, 1976) were found to be limited in their application to lean manufacturing as they exclude important job characteristics relevant to this context (Conti et al., 2006; de Treville & Antonakis, 2006; Jackson et al., 1993). In addition, the use of these models assumes that all job characteristics within the lean context impact employee well-being through one single (motivational or strain) process. This has led to inconsistent results when examining both positive and negative outcomes of lean manufacturing (e.g. Jackson & Mullarkey, 2000). In this study, using the JD-R framework (Demerouti et al., 2001), two distinct psychological processes which occur simultaneously as a result of lean job design are demonstrated, one which is motivational in nature, and one which is health-impairing. Those prominent job resources and demands applicable to lean manufacturing are identified, and their direct and combined impact on both motivational (i.e. work engagement) and health-related (i.e. exhaustion) outcomes are examined. This is carried out using the case of a multi-national pharmaceutical organisation with extensive levels of long term lean usage (Shah & Ward, 2007). Although the JD-R model has frequently been used across a wide variety of contexts to examine the motivational and health-implications of particular jobs, no study to date has identified this framework as critical in terms of capturing both negative and positive effects of lean design and the complex relationships through which it influences employees in terms of motivation and health. The adaption of this model to the lean context highlights the need to discriminate between positive and negative characteristics of lean work (i.e. resources and demands), and their subsequent role in predicting motivational and health-impairment outcomes for employees. Furthermore, it reveals previously unexamined interactions between its positive and negative working conditions, which call into question the established perspective of lean-specific demands as damaging for the quality of working-life (e.g. Landsbergis et al., 1999). The validation of this model supports the findings of most recent studies which reported both positive and negative employee outcomes of lean manufacturing (Anderson-Connolly et al., 2002; Conti et al., 2006; Godard, 2001; Jackson & Mullarkey, 2000; Seppällä & Klemola, 2004), and in doing so it provides a clearer explanation of why and how this occurs. These findings also allow us to move beyond the question as to whether lean has positive or negative effects, towards the question of how to balance lean-specific resources and lean-specific demands to create jobs which are equally efficient for the organisation and enriching for the employee.

3.2 Lean Manufacturing

Lean manufacturing has become one of the most widely used production systems internationally as organisations come under increased pressure to compete on product cost, quality, and service. Its implications for operational improvements and organisational performance have been continuously demonstrated (Brown et al., 2006; Fullerton & Wempe, 2009). The meaning and measurement of lean manufacturing has been a regularly debated topic from the original coining of the term in the late 1980s (Krafcik, 1988; Womack et al., 1990) to the development of concrete definitions and measurement tools in recent years (Shah & Ward, 2007). It is now understood as a multidimensional approach to manufacturing which encompasses a wide range of management practices within an integrated socio-technical system dedicated to minimising waste (Shah & Ward, 2003; 2007). The inclusion of the terms ‘socio’ and ‘technical’ support those who claim that it needs to be regarded as a culture which integrates both its technical tools and management philosophies (Birdi et al., 2008; de Menezes et al., 2010). Its technical tools are used to reduce waste in human effort, inventory, time to market and manufacturing space (see Table 3.1 for definitions). As a management philosophy however, lean manufacturing is intended to change how people work by giving them more challenging jobs, greater responsibility and an opportunity to work in teams (MacDuffie & Pil, 1995; Womack et al., 1990). Recent research in operations management has demonstrated that lean practices work in unison whereby their impact on operational performance is determined by their combined effect rather than individual effects (Birdi et al., 2008; de Menezes et al., 2010; Shah & Ward, 2003). Therefore, the treatment of lean manufacturing as an “integrated system” which reflects an “unobserved managerial philosophy” has come to be recognised as most appropriate when using it to predict outcomes (de Menezes et al., 2010, p. 13). This integrated approach is similar to research on HRM bundles of practice, the findings of which suggest that there are difficulties in interpreting the connections between component practices in isolation from other practices (Huselid, 1995; Macduffie, 1995; Pil & MacDuffie, 1996). Although this integrated approach to examining lean manufacturing is considered superior to assessing individual practices, authors have struggled to identify a model which captures the complexity of job design and subsequent contingent outcomes for employees in this unique context. The JD-R model is considered to be particularly apposite in explaining these opposing effects in the lean manufacturing context.

Table 3.1 Lean Manufacturing Practices (Shah & Ward, 2007).

Practice	**Definition**
Supplier Feedback	Provide regular feedback to suppliers about their performance
Supplier Development	Develop suppliers so they can be more involved in the production process of the focal firm
Just-in-Time Delivery by Suppliers	Ensure that suppliers deliver the right quantity at the right time in the right place
Continuous Flow	Establish mechanisms that enable and ease the continuous flow of products
Total Preventative Maintenance	Address equipment downtime through total productive/preventative maintenance and thus achieve a high level of equipment availability
Employee Involvement	Employees’ role in problem solving and their cross functional character
Customer Involvement	Focus on a firms’ customers and their needs
Reduced Setup Times	Reduce process downtime between product changeovers
Statistical Process Control	Ensure each process will supply defect free units to subsequent processes
Pull Systems	Facilitate JIT production including kanban cards which serve as a signal to start or stop production

3.3 The Job Demands-Resources Model and Lean Manufacturing

The socio-technical nature of lean manufacturing implies that uniform positive or negative effects or causal linear effects on the working environment should not be expected (Hasle et al., 2012). As previously outlined, models such as the JD-C model (Karasek, 1979) and the JCM (Hackman & Oldham, 1976) were found to have limited use in the lean context due to their limited selection of job characteristics and their treatment of all characteristics as similar in nature (Conti et al., 2006; de Treville & Antonakis, 2006; Jackson et al., 1993). The JD-R model, however, facilitates two sets of working conditions in predicting employee well-being which, although related, capture two psychologically distinct processes (Bakker & Demerouti, 2007; Schaufeli & Bakker, 2004). First, a motivational process takes place where job resources satisfy employees' basic needs for autonomy, competence and relatedness (Hakanen & Roodt, 2010; Mauno et al., 2007) and foster motivational outcomes such as work engagement. Work engagement, the motivational outcome of interest in this study, is defined as a positive, fulfilling, work-related state of mind characterised by vigour, dedication and absorption (Schaufeli et al., 2002). Its relevance to the proposed model, which examines the effects of job design under lean manufacturing, stems from its demonstrated ability to enable employees to simultaneously meet and exceed their work goals while maintaining their personal well-being (for an overview see Demerouti & Cropanzano, 2010). Job resources refer to those physical, psychological, social or organisational aspects of the job that are either functional in achieving work goals, reducing job demands and the associated physiological and psychological costs, and stimulate personal growth, learning and development (Demerouti et al., 2001). Under the JD-R framework, job resources which have been found to predict motivational outcomes to date include performance feedback, social support, supervisory coaching (Schaufeli & Bakker, 2004), job control, information, innovative climate and social climate (Hakanen et al., 2006), reward, recognition and value fit (Koyuncu et al., 2006). Some evidence also supports the notion of cross-linkages between job resources and ill-health, whereby a lack of resources leads to burnout (e.g. Schaufeli & Bakker, 2004). Of the studies which address the well-being implications of lean manufacturing, a number of job characteristics specific to this context have been found to reduce negative health outcomes such as stress. Examples of these lean-specific job resources include team working (Conti et al., 2006), skill utilisation (Sprigg & Jackson, 2006), autonomy (Anderson-Connolly et al., 2002), social climate (Jackson & Mullarkey, 2000) and participation (Parker, 2003) (for an overview see Cullinane, Bosak, Flood & Demerouti, 2013).

This study focuses specifically on boundary control, performance feedback and training provision as job resources which represent important and unique characteristics of lean job design (Anderson-Connolly et al., 2002; Cullinane et al., 2013; de Treville & Antonakis, 2006; Forza, 1996; Jackson & Mullarkey, 2000). Boundary control refers to the extent to which operators are involved in a variety of activities associated with traditional supervisory or first-line management activities (e.g. machine maintenance, inspection, quality assurance etc.). This specific form of autonomy whereby employees actively participate in day-to-day decision making is an established characteristic of lean work and has been found to increase job satisfaction and psychological well-being while also reducing job pressure (Jackson & Mullarkey, 2000; Mullarkey et al., 1995; Wall et al., 1990). The use of statistical process controls, visual displays and frequent team meetings (drumbeat meetings) promote the delivery of clear and direct feedback to employees under lean manufacturing. Unlike traditional mass production, these forms of feedback are necessary for employees under lean manufacturing in order to track process quality issues such as defect rates, frequency of machine breakdowns and monitor the progress of each production process. Although no relationship has yet been established between feedback and well-being under lean manufacturing, it is a significant determinant of positive outcomes such as work engagement, job satisfaction, and motivation in alternative contexts (Humphrey et al., 2007; Schaufeli & Bakker, 2004). Similarly, the provision of training is a recognised characteristic of lean manufacturing in terms of multi-skilling activities and formal training in areas of technical and interpersonal skills (e.g. Adler 1990; de Treville & Antonakis, 2006). Using European Cranfield data, Kabst et al. (1996) found that employees operating within lean organisations were more involved in training activities than those in non-lean organisations. Furthermore, they found additional features of training and development such as the use of work groups for quality improvement, product development and task flexibility, and training in quality, customer service and people management to be greater in lean organisations. However, training has not been found to predict well-being within the lean context despite its positive association with job satisfaction, task enjoyment, and organisational commitment in alternative contexts (Bakker et al., 2010; Morgeson & Humphrey, 2006). In light of previous results regarding the positive role of job characteristics under lean manufacturing and the role of job resources in promoting motivational outcomes and reducing ill-health in JD-R studies, resources stemming from lean manufacturing (i.e. boundary control, feedback and training) are expected to be positively related to motivational outcomes (i.e. work engagement) and negatively related to negative health-related outcomes (i.e. exhaustion). As a result, the following is hypothesised:

Hypothesis 1: Lean-specific job resources will be positively associated with work engagement.

Hypothesis 2: Lean-specific job resources will be negatively associated with exhaustion.

Second, a health impairment process takes place where high job demands exhaust employees' mental and physical resources leading to burnout and eventually to ill-health. Exhaustion is a consequence of intense physical, affective and cognitive strain whereby an employees' energy is drained, leaving them incapable of performing their job. Job demands refer to those physical, psychological, organisational and social aspects of the job that require sustained physical/psychological effort or skills and therefore are associated with physical/psychological costs (e.g. high work pressure, unfavourable physical environment, emotionally demanding interactions with clients) (Bakker & Demerouti, 2007). Although studies using the JD-R framework have consistently demonstrated the strong positive relationship between job demands and burnout, most of these studies found no relationship ,either positive or negative, between job demands and work engagement (e.g. Hakanen et al., 2006; Schaufeli & Bakker, 2004; Schaufeli et al., 2009) or a weak relationship (Hu et al., 2011). Reviews of studies which address the health effects of lean manufacturing have found negative effects to dominate, particularly in the automobile industry (Hasle et al., 2012; Landsbergis et al., 1999). Demands resulting from lean manufacturing which have been found to predict ill-health include production pace, work intensity, monitoring pressures, and team conflict (Conti et al., 2006; Jackson & Mullarkey, 2000; Sprigg & Jackson, 2006). Demands of a more challenging nature including decision making (MacDuffie & Pil, 1995), problem solving (Delbridge et al., 2000) and production responsibility (Jackson & Mullarkey, 2000), have also been associated with lean work (for an overview see Cullinane et al., 2013).

This study focused specifically on production pace, problem solving, accountability and task interdependency as indicators of lean-specific job demands. Production pace and problem solving have previously been identified as predictors of well-being under lean manufacturing (Cullinane et al., 2013; Delbridge et al., 2000; Jackson & Mullarkey, 2000; Sprigg & Jackson, 2006). However, accountability and task interdependency, both social demands, have not yet been recognised as salient lean demands. The principles associated with socio-technical systems such as lean manufacturing promote work design within which interdependent tasks are grouped together in order to maximise group-autonomy and reduce the need for decision making outside the immediate work group (Klein, 1991; Susman, 1976). Following the redesign of the shop floor into multidisciplinary production units within which all activity is oriented towards the production of a single product or family of products, employees become dependent on one another’s skills and manpower for the completion of tasks. These social demands however are rarely examined as predictors of well-being in this context largely because of their exclusion from previous job design models such as the original JCM (Hackman & Oldham, 1976) and the JD-C model (Karasek, 1979). However, outside the context of lean manufacturing these demands have become recognised as significant work stressors (Hall et al., 2006; Royle, Hall, Hochwarter, Perrewe & Ferris, 2005; Wong, DeSanctis & Staudenmayer, 2007). The above cited findings from studies using the JD-R model, examining lean manufacturing and job design more generally (Humphrey et al., 2007) suggest that lean-specific job demands (i.e. production pace, problem solving, accountability and task interdependency) are positively related to negative health-related outcomes (i.e. exhaustion). As a result, the following is hypothesised.

Hypothesis 3: Lean-specific job demands will be positively associated with exhaustion.

In addition to these dual processes, on the basis of the COR theory (Hobfoll, 1989; 2002) and the strain and learning hypotheses of the JD-C model (Karasek & Theorell, 1990), the JD-R model also proposes that job resources buffer the negative effects of job demands on health-related employee outcomes (Bakker & Demerouti, 2007). Using the JD-R framework, a number of studies have found support for this buffer effect on negative outcomes such as burnout across multiple occupations (Bakker et al., 2004), and specifically with home care staff (de Jonge et al., 2008; Xanthopoulou et al., 2007) and higher education teachers (Bakker et al., 2005). More recently, the JD-R model has been extended to propose a motivational hypothesis whereby job resources have a stronger relationship with motivational outcomes in the face of high job demands. Hakanen et al. (2005) found that variability in professional skills increased work engagement when employees were confronted with high qualitative workload, and diminished the negative effect of high workload on engagement. Similarly, Bakker et al. (2007) found that job resources buffered and mitigated the negative relationship between pupil misbehaviour and teacher work engagement. This coping hypothesis presented by the JD-R model suggests that job resources supply strategies for dealing with job demands, and are less of a concern to individuals experiencing little to no demands in their job (Bakker et al., 2007; Seers et al., 1983). Therefore, the motivational potential of 'active jobs' (Karasek & Theorell, 1990) stems from their ability to combine demanding work with adequate resources. Although these interactive effects between job resources and job demands remain untested in the lean manufacturing context, a number of authors have indirectly referred to similar combinations of job characteristics which aid employees in dealing with uncertainty and variability in the production process and provide a healthier work environment (e.g. MacDuffie & Pil, 1995; Womack et al., 1990). Considering the above evidence from JD-R studies and existing theoretical knowledge of the working environment under lean manufacturing, the following moderations of the motivational and health-impairment processes are predicted.

Hypothesis 4: Lean-specific job demands moderate the relationship between lean-specific job resources and work engagement such that the relationship will be strengthened given high rather than low lean-specific demands.

Hypothesis 5: Lean-specific job resources moderate the relationship between lean-specific job demands and exhaustion such that the relationship will be weakened given high rather than low lean-specific resources.

3.4 Method

3.4.1 Context

This study took place in an Irish subsidiary of a large European multinational organisation which operates as part of the manufacturing arm of their pharmaceutical division and employs approximately 390 people. Lean manufacturing was first introduced to this organisation in 2003 with the goal of sustainable reductions in cycle time, inventories, and costs. The level of lean implementation on site was determined through administration of a lean assessment survey (Shah & Ward, 2007) to the Head of Automation, whereby the level of implementation for each practice was indicated on a scale from 1 (No Implementation) to 5 (Complete Implementation). All practices (see Table 3.1) had a minimum of 3 (Some implementation) with extensive or complete implementation in most areas including supplier feedback and development, customer involvement, set-up time reduction, preventative equipment maintenance, employee involvement and continuous flow. Items relating to visual process management, where visual displays are used around the shop floor to present the progress of the process, were also included in the assessment following recommendation from the authors of the scale (Shah & Ward, 2007). This practice was also rated as extensively implemented. With the objective of aligning the people within the company to the principles of lean manufacturing the organisational structure was modified by introducing a flat and cross-functional structure with only three hierarchical layers (site head, production unit head, operating team member) to replace the previous structure of six layers.

Traditionally departments or functions were silo-based and utilised a ‘chain of command' hierarchy. However, following the introduction of lean manufacturing, all functions (e.g. manufacturing, quality assurance and control, maintenance etc.) were integrated within a larger ‘process unit’ which operates either one or a number of manufacturing lines as a single cross-functional and self-directed team.

3.4.2 Employee Survey

The specific resources and demands relevant to the lean context were identified following a review of the literature and via exploratory data collection with employees within the case site (attendance at off-site training days, informal focus groups and interviews). The survey was administered to 144 employees using paper and pen method, while the remaining employees were emailed an online version of the survey. The survey was given to all employees working directly in manufacturing (310 employees), 200 of which were returned. Therefore, the total response rate for this company site was 64.5%. Respondents were predominantly male (84%). 7.9% had worked for the organisation for less than three years, 21.9% between four and eight years, and 70.2% for more than nine years. 37% of the respondents were day workers (i.e. 9am to 5pm) while 63% were shift workers (i.e. 8am/pm to 8am/pm). In terms of position, 60% of respondents were members of the operating teams, 29% were support team members and 12% were from the quality assurance team. The sample was considered representative as it did not significantly differ from the total population in terms of gender (80% male) and worker type (71% shift work and 29% day work).

3.4.3 Measures

3.4.3.1 Job Resources. *Boundary control* was measured using a 7-item scale (Mullarkey et al., 1995). Example items include “To what extent can you call out support yourself when there is a machine problem?” and “To what extent can you inspect the quality of your own work?" Participants responded on a 5-point scale from 1 (Not at all) to 5 (A great deal). Cronbach's alpha was .79.

Performance feedback was measured using a 6-item scale which included statements referring to feedback received from colleagues, superiors and the job itself (Hackman & Oldham, 1975). Example items include "My co-workers often let me know how well they think I am performing in the job" and "The job itself provides information about my performance". Participants responded on a 5-point scale from 1 (Strongly disagree) to 5 (Strongly agree). Cronbach's alpha was .75.

Training provision was measured using a 3-item scale (Campion, Medsker & Higgs, 1993). Example items include "The company provides adequate technical training for my team" and "The company provides adequate team skills training for my team (e.g. communication, interpersonal etc.)". Participants responded on a 5-point scale from 1 (Strongly disagree) to 5 (Strongly agree). Cronbach's alpha was .81.

3.4.3.2 Job Demands. *Production pace* was measured using a 3-item scale (Mullarkey et al., 1995). Example items include "To what extent do you find that work piles up faster than you complete it?" and "To what extent are you under constant pressure at work?". Participants responded on a 5-point scale from 1 (Not at all) to 5 (A great deal). Cronbach's alpha was .89.

Problem solving demands were measured on a 5-item scale (Jackson et al., 1993; Wall et al., 1995). Example items include "To what extent are you required to deal with problems which are difficult to solve?" and "To what extent do you have to use your knowledge of the production process to help prevent problems arising in your job?". Participants responded on a 5-point scale from 1 (Not at all) to 5 (A great deal). Cronbach's alpha was .81.

Accountability was measured using a 7-item scale (Hochwarter, Kacmar & Ferris, 2003). Example items include "I have to explain why I do certain things at work" and "My team hold me accountable for all of my decisions". Participants responded on a 5-point scale from 1 (Strongly disagree) to 5 (Strongly agree). Cronbach's alpha was .75.

Task interdependency was measured using a 3-item subscale of a 6-item work interdependence scale (Campion et al., 1993). Example items include "I cannot get tasks done without information and materials from other team members" and "Members of my team have skills and abilities that complement each other". Participants responded on a 5-point scale from 1 (Strongly disagree) to 5 (Strongly agree). Cronbach's alpha was .57.

3.4.3.3 Employee Outcomes. *Work engagement* was measured using the vigour (3 items) and dedication (3 items) subscales (representing 'core engagement'; Demerouti, Mostert & Bakker, 2010; Salanova & Schaufeli, 2008) from the shortened version of the Utrecht Work Engagement Scale (UWES; Schaufeli, Bakker & Salanova, 2006). Examples statements include "At work I feel bursting with energy" and "I am proud of the work that I do". Participants responded on a 7-point frequency scale from 1 (Never) to 7 (Always/Everyday). Cronbach's alpha was .92.

Exhaustion was measured using the exhaustion subscale (8 items) from the Oldenburg Burnout Inventory (OLBI; Demerouti et al., 2001). Examples include "After work I usually feel worn out and weary" and "When I work, I usually feel energised". Participants responded on a 5-point scale from 1 (Strongly disagree) to 5 (Strongly agree). Cronbach's alpha was .78.

3.5 Analysis

To test the hypotheses, moderated structural equation modelling (MSEM) analyses was conducted with the Mplus statistical package (version 6.12; Muthén & Muthén, 1998-2010) using the maximum-likelihood method of estimation (Bollen, 1989). The fit of the model to the data was evaluated using several goodness-of-fit indices including: the χ^2 value, the Root Means Square Error of Approximation (RSMEA), the Standardized Root Means Square Residuals (SRMR) the Comparative Fit Index (CFI), and the Tucker-Lewis index (TLI). RMSEA and SRMR with values of .05 or less indicate a good fit, values .06 –.08 an adequate fit, and values close to .10 a mediocre fit (Schermelleh-Engel, Moosbrugger & Muller, 2003). CFI and TLI values larger than 0.90 indicate good fit, whereas values larger than 0.95 indicate excellent fit (Bentler, 1990).

In order to confirm the four-factor structure (i.e. lean-specific job demands, lean-specific job resources, work engagement, and exhaustion) for the measurement model a confirmatory factor analysis using the latent variables was carried out in the first step. The theoretical model with structural paths was tested in the second step. The latent exogenous job resources and job demands were operationalised by three and four observed variables respectively (see above). The model also consisted of two endogenous latent dependent variables: work engagement and exhaustion. Both work engagement and exhaustion were operationalised by one indicator (the respective scales of the UWES and the OLBI) to ensure a parsimonious model. Measurement error was corrected by setting the random error variance associated with each construct equal to the product of its variance and the quantity one minus the estimated reliability (Bollen, 1989; cited in Bakker et al., 2004). Finally, the latent job design factors of job resources and job demands were allowed to correlate, and the hypothesised relationships were included in the model. Further, the residual errors of the two outcome variables were allowed to correlate. In order to test the interaction hypotheses (see Hypotheses 4 and 5), MSEM analyses were carried out. The interactions between latent variables (i.e. lean-specific demands and resources) were estimated using the XWITH command in Mplus. This approach creates indicators for the latent interaction term with the factor loadings calculated using the products of the indicators for the predictor and moderator variables (Klein & Moosbrugger, 2000). The models included direct paths from the three exogenous variables (lean resources and lean demands and their interaction) to the two endogenous variables (work engagement and exhaustion). A significant interaction effect is evident when the path coefficient from the interaction term to the endogenous factors is statistically significant.

As all measures were rated by the focal employee, common method bias was tested by computing a confirmatory factor analysis for the four latent variables with and without a same-source first-order factor added test. This unmeasured latent method factor was set to have indicators of all self-report items, therefore controlling for the portion of variance attributable to obtaining all measures from a single source (see Podsakoff, MacKenzie & Podsakoff, 2012). As all factor loadings and intercorrelations were almost identical in both models (factor loadings 0.43-0.87; intercorrelations -0.71- 0.57), common method variance was not believed to be a source of bias in the data.

3.6 Results

3.6.1 Descriptive Statistics

Table 3.2 presents the means, standard deviations, correlations and the internal consistencies of the scales included in this study. Demographic variables (e.g. position, tenure) were not statistically related to the dependent variables within the model (i.e. work engagement and exhaustion), and were therefore omitted from further analysis to avoid misinterpretation of the results (Spector & Brannick, 2011).

Table 3.2 Descriptive Statistics and Correlations between Variables of Study 2

	Mean	**SD**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1. Boundary Control	3.09	.84	(.79)								
2. Feedback	2.93	.68	.39**	(.75)							
3. Training	2.70	.88	.31**	.39**	(.81)						
4. Prod Pace	3.10	1.05	.00	-.14	-.14*	(.89)					
5. Problem solving	3.52	.83	.08	-.08	-.21**	.51**	(.81)				
6. Accountability	3.59	.58	.06	.06	.08	.49**	.56**	(.75)			
7. Interdependency	3.40	.70	.00	-.03	-.06	.33**	.37**	.40**	(.57)		
8. Work Engagement	5.04	1.27	.37**	.23**	.21**	-.15*	.06	.02	-.02	(.92)	
9. Exhaustion	2.84	.60	-.12	-.21**	-.21**	.57**	.23**	.26*	.23**	-.52**	(.78)

3.6.2 Measurement Model

To establish the discriminant validity of the latent factors, a full measurement model was estimated comprising the job characteristics (i.e. lean resources and lean demands), and the dependent variables (i.e. work engagement and exhaustion). The four-factor measurement model showed acceptable fit to the data: χ^2 (22) = 41.28, RMSEA = 0.067, SRMR = 0.061, CFI = 0.945, TLI = 0.911. All observed variables had significant ($p<0.001$) loadings ranging from 0.50 to 0.96 on their latent factor (Mean = 0.69). Therefore a reliable measurement model was obtained. In order to test the discriminant validity between resources and demands, and work engagement and exhaustion, the model was also run as a three-factor, a two-factor, and a single latent model which demonstrated significantly worse fit than the four-factor model (see Table 3.3)

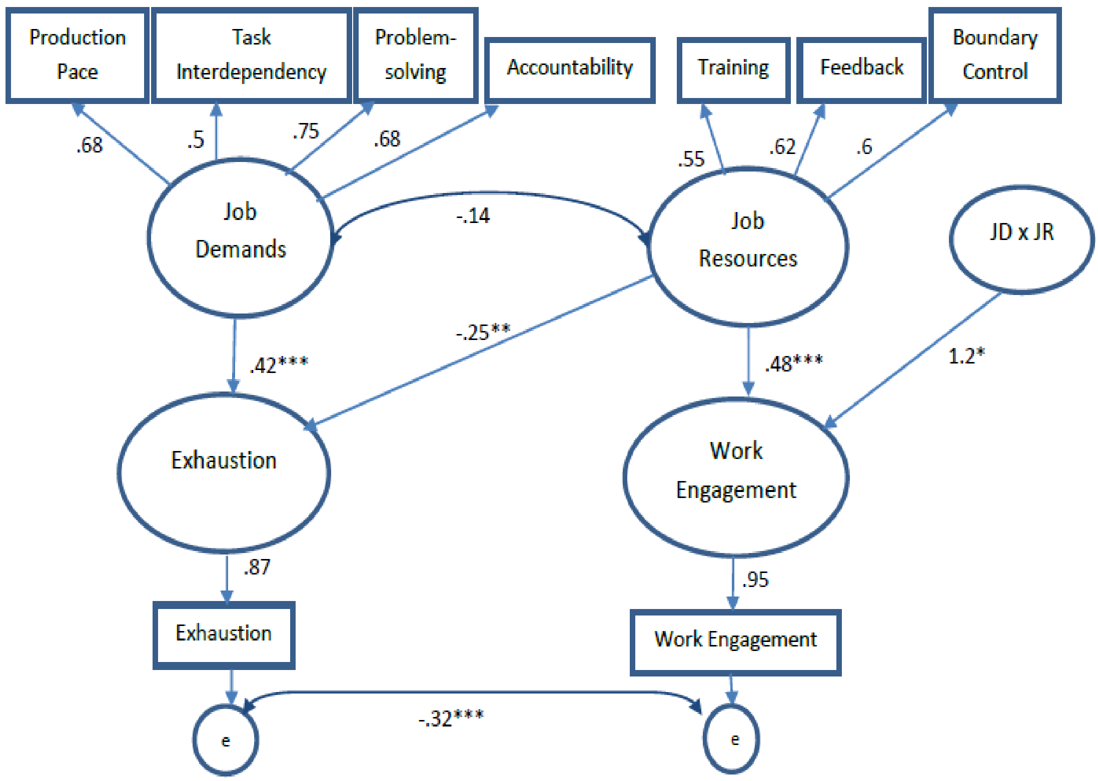
Table 3.3 Measurement Model Fit Indices.

	χ^2	**d.f.**	**RMSEA**	**SRMR**	**CFI**	**TLI**
1. 4-factor model (job resources, demands, work engagement and exhaustion)	41.28	22	.067	.061	.945	.911
2. 3-factor model (job characteristics, work engagement and exhaustion)	116.73	25	.136	.121	.740	.626
3. 2-factor model (job characteristics, health-related outcomes)	147.69	27	.151	.146	.658	.544
4. 1-factor model (all variables)	260.29	28	.205	.216	.342	.154

3.6.3 Test of the Direct JD-R Model Relationships

To begin, a model was tested which included the direct hypothesised relationships between lean resources and work engagement, and lean demands and exhaustion, and the cross-link between lean resources and exhaustion. The results of the SEM demonstrates acceptable fit to the data; χ^2 (22) = 41.28, RMSEA = 0.067, SRMR = 0.061, CFI = 0.945, TLI = 0.911. Lean resources were positively related to work engagement (β = 0.484 p = .000) and negatively related to exhaustion (β = -0.253 p = .004). Lean demands were positively related to exhaustion (β = 0.425 p = .000) yet were unrelated to work engagement (β = 0.019 p = .839). The modelled variables explained 24% of the variance in work engagement and 27% of the variance in exhaustion (see Figure 3.1). Therefore support was found for Hypotheses 1, 2 and 3.

Figure 3.1 Factor Loadings and Path Coefficients of Model



3.6.4 Test of Interactive Effects of Job Resources and Demands

In order to test Hypotheses 4 and 5, a moderated structural equation modelling (MSEM) analysis was carried out. A model which included three exogenous latent variables was tested: lean demands, lean resources, and lean demands x lean resources. The indicator of the latent interaction variable was the multiplication of the standardised scales scores of the individual lean resources and demands tested. The MSEM analysis found the relationship between the lean resources/lean demands interaction and work engagement to be statistically significant (b = 1.207 p = .020). To further examine the nature of the significant interaction effect, a graphical representation was produced using the procedure outlined by Aiken and West (1991). Figure 3.2 shows the interaction between lean demands and lean resources with regard to work engagement for employees. The interaction plot shows that, as predicted, the positive relationship between lean resources and work engagement was stronger when demands were high rather than low. Therefore Hypothesis 4 was supported. The relationship between the lean resources/lean demands interaction and exhaustion however was not statistically significant ($b = -0.476$ $p = .055$), therefore Hypothesis 5 was not supported. Because the significance value was close to the $p < .05$, the interaction was inspected to see whether there was a trend in the expected direction. As can be seen in Figure 3.3 and similar to Hypothesis 5, lean resources buffer the relationship between lean demands and exhaustion.

Figure 3.2 Interaction Plot for the Relationship between Lean Resources and Work Engagement as Moderated by Lean Demands

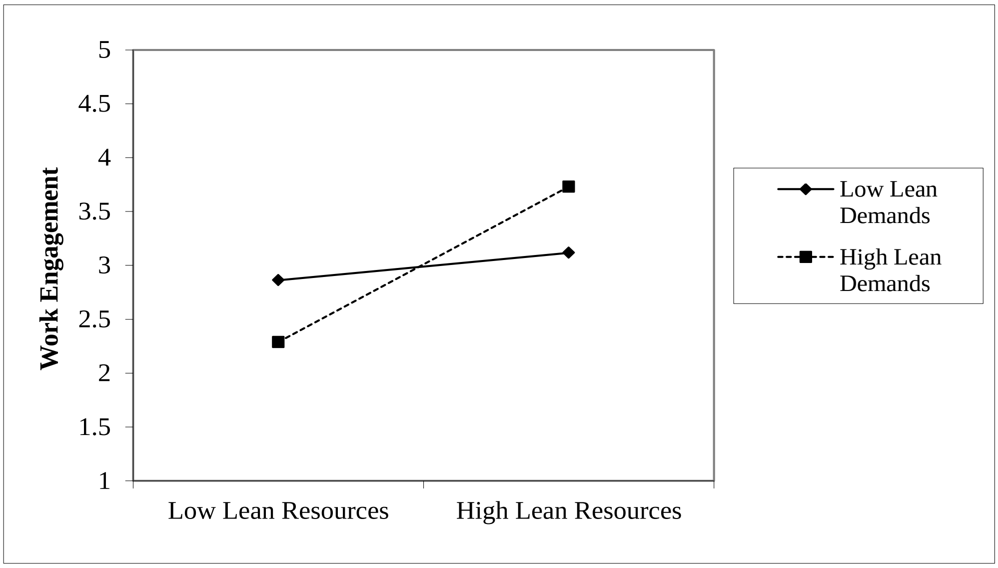
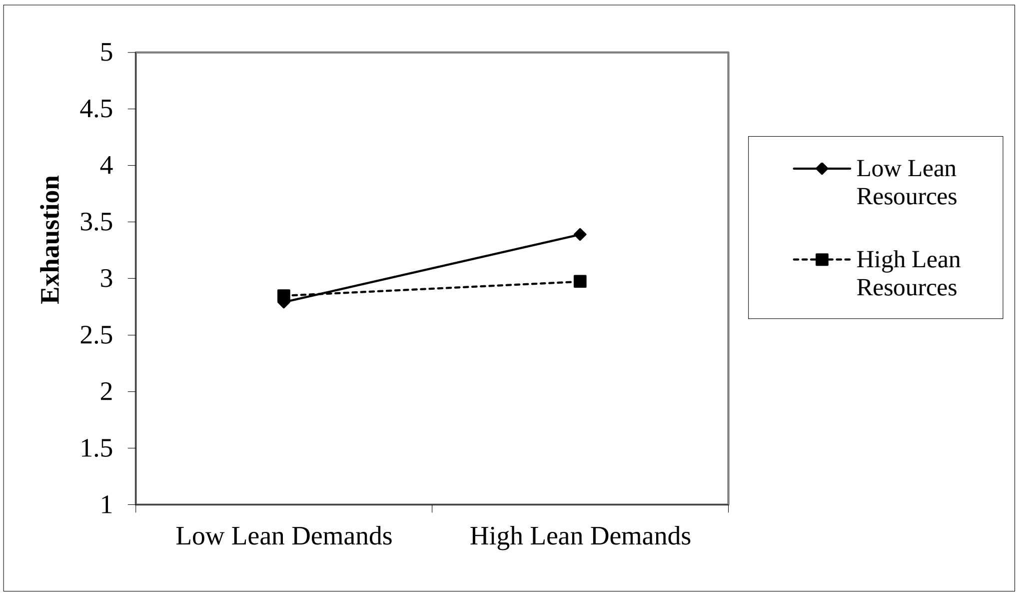


Figure 3.3 Interaction Plot for the Relationship between Lean Demands and Exhaustion as Moderated by Lean Resources



3.7 Discussion

In this study, a framework through which job design under lean manufacturing predicts motivational and health-related outcomes for employees was proposed and examined. The results supported the hypothesised direct relationships between lean resources and work engagement, lean resources and exhaustion, and lean demands and exhaustion. These findings demonstrate that lean manufacturing is simultaneously a demanding and resourceful work environment with engaging and exhausting properties. The hypothesised interactive effect between lean resources and lean demands was also supported, whereby the positive relationship between lean-specific resources and work engagement is strengthened by the presence of lean-specific demands. The results are consistent with existing literature supporting the direct and interactive relationships within the JD-R model (e.g. Bakker & Demerouti, 2007; Hakanen et al., 2005; Schaufeli & Bakker, 2004). The findings also support previous research which demonstrates the health-impairing role of lean demands such as production pace and monitoring demands, and the motivational role of lean resources such as team working, skill utilisation and autonomy (Conti et al., 2006; Jackson & Mullarkey, 2000; Sprigg & Jackson, 2006). The adaption of the JD-R framework to the lean manufacturing context however moves beyond previous studies which treat lean characteristics as variables with either positive or negative outcomes by differentiating between two psychologically distinct processes which occur in this context. This is evident by the superior fit of the four-factor model.

To the author's knowledge, no empirical study which addresses the positive and negative characteristics of job design under lean manufacturing has yet addressed the interactive effects of these distinct characteristics in predicting employee psychosocial outcomes. The interaction between lean-specific resources and demands found in the present study demonstrates that in addition to the motivational potential of lean resources, lean demands such as problem solving and accountability increase the motivational potential of lean resources. Although lean demands in isolation deplete the energy of employees, they act as motivational challenges which predict work engagement when combined with lean resources. Therefore, where previous studies concluded that in order to promote a positive work environment lean demands should be minimised and lean resources maximised, this interaction adds a new layer of complexity to both the theoretical and practical implications of existing knowledge regarding the quality of working life under lean manufacturing. Support for the hypothesised direct relationships also validates the findings of studies which revealed both positive and negative employee outcomes of lean manufacturing (Anderson-Connolly et al., 2002; Conti et al., 2006; Godard, 2001; Jackson & Mullarkey, 2000; Seppällä & Klemola, 2004;). Furthermore it provides a single framework within which these contingencies can be incorporated.

3.8 Implications for Practitioners

On reviewing the literature surrounding the impact of lean manufacturing on employee outcomes, Hasle (2012) claims that a picture in which positive and negative effects thrive side by side has emerged. Therefore, the question is how to simultaneously minimise adverse effects while enhancing the positive effects. In particular, the findings demonstrate the crucial role of lean resources (i.e. provision of training, boundary control and feedback) for promoting engagement and reducing exhaustion. Support for the interaction hypotheses indicate that the demands associated with lean manufacturing should not be considered as damaging or characteristics which should be minimised. Rather, managers should focus their efforts on the provision of resources which stimulate the motivational challenge of demands such as increased work pace, responsibility and dependency on others. For example, permanent on-going training, teambuilding, upward occupational mobility, task rotation and the creation of a knowledge-sharing culture of cooperation (Schuring, 1996) will support employees in their problem solving activities. Similarly, the delegation of traditional supervisory tasks such as training, quality inspection and scheduling to the shop floor will allow employees to maintain a steady work pace and work interdependently without constantly seeking supervisory permission to deal with arising production issues.

3.9 Limitations and Future Research

Although this study provides novel insights into the complexities of job design under lean manufacturing and its relationship with employee psychosocial outcomes such as work engagement and exhaustion, there are a number of limitations. As the current study is limited to a cross-sectional design, a longitudinal examination of the above proposed framework in a stabilised lean environment would further validate the relationships found and permit the inference of causality between lean job design and employee outcomes. A longitudinal design would also permit the examination of potential reverse causal effects whereby employees who become more engaged in their work further increase their lean resources (e.g. seek further feedback, up-skilling activities etc.) to cope with increasing lean demands such as shortened cycle-times and pressure for problem solving (Llorens, Schaufeli, Bakker & Salanova, 2007). Previous studies, with the exception of Conti et al. (2006), have struggled to infer clear and distinct causal relationships between lean practices, job characteristics and employee outcomes due to methodological limitations, namely small samples of organisations. Hasle and colleagues (2012) conclude that future studies should be designed to examine the relations between the ten dimensions of lean manufacturing (outlined in Table 3.1; Shah & Ward, 2007) and the work environment. This calls for the use of multi-level or multi-group analysis which examine the relationships outlined above across organisations or between units within organisations with varying levels of lean manufacturing usage.

As this study is specific to the pharmaceutical industry, future researchers are advised to further validate the above results regarding lean-specific demands and resources for additional types of chemical manufacturing which share similarities in process complexity (e.g. requirement of regular and timely product changeover while preventing cross-contamination), and alternative industries which have lower levels of process complexity. Of the studies which demonstrate negative effects of lean manufacturing, all job roles were manual in nature and had low levels of complexity (Hasle et al., 2012). Some findings suggested that working conditions under more complex job roles for qualified employees were in fact improved as a result of lean manufacturing (Parker, 2003; Schouteten & Benders, 2004). Seppällä and Klemola (2004) on the other hand found that the work of white collar groups was more heavily impacted by lean manufacturing than that of blue collar groups in terms of increased pressure and responsibility. Future research should consider using multi-group analysis to examine the measurement and structural models demonstrated in this study across different occupational groups and industries using lean manufacturing.

Lean manufacturing takes many forms and a variety of contextual considerations (e.g. extent and length of implementation, industry type, level of employee involvement in implementation) should be considered when assessing its impact (Conti et al., 2006; Hasle et al., 2012; Parker, 2003). A number of studies, including the present one, outline the implementation process to contextualise the research findings. However, without more detailed analysis the extent to which the implementation strategy impacts employee outcomes is unclear (Hasle et al., 2012). If lean manufacturing is implemented in an intensely competitive market and accompanied with industrial relations disputes, down-sizing or up-sizing these factors can have a strong impact on employees (Anderson-Connolly et al., 2002; Bruno & Jordan, 2002; Lewchuck et al., 2001), which can be mistaken as an outcome of lean practices. As existing studies which have accounted for the implementation strategy in their analysis found positive relationships between employee involvement at implementation phase and subsequent well-being outcomes (Conti et al., 2006; Seppällä & Klemola, 2004), future studies should consider its inclusion as a measured variable.

3.10 Conclusion

The present study tested the suitability of the JD-R model as a useful framework to further understand the processes through which job design resultant from lean manufacturing impacts employees. By confirming that the direct and interactive relationships between job design and employee outcomes as proposed in the JD-R model hold for this unique context, it facilitates future research which incorporates previous claims of advocates and critics of lean. With the increased adoption of lean manufacturing techniques across multiple industries it is becoming increasingly important for organisations to consider how the health-impairing potential of new demands such as shortened cycle-times and increased problem solving for operatives can be minimised and used as a means of providing motivational challenges with the provision of appropriate and complementary lean resources.

Evidence is growing to suggest that employee well-being is a dynamic and continuous process which often takes place over short periods of time (Sonnentag et al., 2010; Xanthopoulou et al., 2010). Despite this, previous studies addressing the well-being implications of lean manufacturing (including the study presented in this chapter and the previous chapter), have focused exclusively on relationships at the between-person level where job characteristics and employee outcomes are considered to be relatively stable. In response to this, the next chapter presents a study which examines the daily relationships between lean-specific job design, employee job crafting and work engagement using a within-person approach. A daily diary study collected with 64 employees over four working days is presented to test the hypothesised daily relationships and capture the daily experience of employees working under lean manufacturing.

Chapter Four

Facilitating Daily Crafting and Engagement under Lean Manufacturing: The Role of Resources, Demands and Challenges

Based on: Cullinane, S. J., Bosak, J., Flood, P. C. & Demerouti, E. (under review), Facilitating Daily Crafting and Engagement under Lean Manufacturing: The Role of Resources, Demands and Challenges.

4.1 Introduction

The study of job-related actions that employees engage in to progress toward 'optimal functioning' has increasingly attracted considerable interest from both researchers and practitioners alike (Wrzesniewski, LoBuglio, Dutton & Berg, 2013). Job crafting, referred to as a 'proactive person-environment fit behaviour' (Grant & Parker, 2009), relates to the changes or modifications employees carry out in their job as a means of adapting to challenges whilst satisfying individual needs (Berg et al., 2010; Wrzesniewski & Dutton, 2001). This bottom-up approach to job design has gained particular interest following its association with a range of positive employee outcomes such as psychological well-being, work engagement and job satisfaction (Bakker et al., 2012; Berg et al., 2010; Tims, Bakker & Derks, 2012). To date, features of job design such as autonomy, work discretion, work pace and task interdependency have been found to either promote or inhibit job crafting activities both in general (Leana et al., 2009), and on a daily basis (Petrou et al., 2012). However, studies which identify and demonstrate how managers can optimally design jobs to facilitate job crafting activities remain scarce.

The influence of context has been considered as both a facilitator and inhibitor of job crafting, as it strongly influences both its antecedents and outcomes (Berg et al., 2010; Leana et al., 2009). In the present study, the unique and complex context of lean manufacturing which promotes both stress inducing and motivational characteristics is focused upon (Anderson-Connolly et al., 2002; Conti et al., 2006). This form of manufacturing employs an array of multidimensional technical practices and management philosophies to promote value and waste elimination in the production system (Shah & Ward, 2003). Although opinions pertaining to the quality of working life for employees under lean manufacturing have been divided to date, consensus has recently emerged that this context has neither uniformly positive or negative effects on employees (Cullinane et al., 2013; Hasle et al., 2012). Models which simultaneously consider both its beneficial and detrimental implications for employee well-being remain unexplored to date, and are therefore necessary to understand how jobs under lean manufacturing can be configured to minimise its stress-inducing characteristics and enhance its motivational characteristics. In addition, research to date which assesses working conditions under lean manufacturing has solely focused on the implications of job redesign by management. Therefore, the importance of individual redesign activities regularly carried out by employees has yet to be considered in this context.

The primary goals of the present study are as follows. First, using a within-person design, this study examines which factors of daily job design under lean manufacturing facilitate daily job crafting activities in which employees expand the motivational boundaries of their job or reduce its psychological costs. In particular, daily resources (i.e. skill utilisation), daily demands (i.e. felt accountability) and daily challenges (i.e. problem solving) specific to the lean context are identified, and the JD-R framework (Bakker & Demerouti, 2013; Demerouti et al., 2001) is used to examine their relationships with daily job crafting. Second, this study draws upon research which identifies task interdependency as a direct inhibitor of job crafting (Wrzesniewski & Dutton, 2001) and a buffer of beneficial work characteristics (Janz, Colquitt & Noe, 1997), and examines its role as a moderator in the relationship between daily job design and daily crafting. Finally, the relationship between daily job crafting and daily work engagement is examined. In particular, this study observes how three job crafting behaviours (seeking resources, seeking challenges and reducing demands) carried out by employees on a given day uniquely impact the degree to which employees are engaged on that day.

This study makes several contributions. First, it adds to the scarce body of literature regarding contextual facilitators of job crafting by examining its relationship with previously unexamined job resources, demands and challenges encountered by employees under lean manufacturing. This study is the first, to the author's knowledge, to examine the impact of job design on job crafting using this three dimensional differentiation of job characteristics (Crawford et al., 2010; Halbesleben, 2010; Van den Broeck et al., 2010). Specifically, this differentiation allows us to simultaneously examine the unique impact of different types of job characteristics, and therefore helps us to determine whether job characteristics which differ in nature vary in their relationships with specific job crafting activities (i.e. seeking resources, seeking challenges and reducing demands). Second, the use of a within-person approach permits the novel examination of daily fluctuations in employees' experience of the lean working environment. Previous studies addressing the implications of lean manufacturing for employees have exclusively focused on relationships at the between-person level where job characteristics and employee psychosocial outcomes are considered to be relatively stable (e.g. Jackson & Mullarkey, 2000; Parker, 2003). However, as employee well-being is considered as a dynamic and continuous process which often takes place over shorter periods of time (Sonnentag et al., 2010; Xanthopoulou et al., 2010), the examination of inter-individual variation is not always appropriate and can lead to inconsistent results (Ohly et al., 2010). Therefore, short term variations within the dynamic constructs of work engagement and job crafting (Berg et al., 2010; Daniels, 2011; Nielsen & Abildgaard, 2012) are examined, which facilitates measurements closer to the actual experience of participants and minimises the bias of retrospective recall (Bolger et al., 2003; Ohly et al., 2010). From a practical perspective, this design enhances the understanding of managers within lean organisations as to how their daily decisions pertaining to job design (e.g. assignment of tasks and responsibilities to employees) can have repercussions for how employees react to their work and the quality of their working day.

Finally, no previous study, to the author's knowledge, has considered the detrimental impact of high task interdependency in the relationship between job design and job crafting. In addition, despite its relevance to the lean manufacturing context (Klein, 1991), task interdependency has not been considered in studies addressing the employee experience of this working environment. By examining this interactive relationship, this study deepens our understanding of contextual constraints of job crafting within this context, and highlights optimal combinations of job characteristics for encouraging employees to proactively redesign their job on a daily basis.

4.2 Lean Job Design and Job Crafting

Job design theory and research has evolved to reflect changes in the workplace from approaches which viewed job design as the responsibility of managers and consultants (Hackman & Oldham, 1975; Herzberg, 1966), to something that can now be modified or restructured by the employee themselves (Grant & Parker, 2009; Oldham & Hackman, 2010). Wrzesniewski and Dutton (2001) note that, in contrast to job design perspectives which assume that the motivating potential of the job prompts employee response, the job crafting perspective claims that employees create this motivating potential by moulding aspects of their job that were traditionally predetermined. More recently, this bottom-up approach to job design has been embedded within the JD-R model (Bakker & Demerouti, 2013) and therefore focuses specifically on the changes employees make to their job characteristics (i.e. job resources and demands; Tims et al., 2012). This approach to job crafting considers three specific crafting activities which can be undertaken by employees, namely increasing job resources, increasing job challenges, and decreasing job demands. These crafting activities closely relate to what Wrzesniewski and Dutton (2001) refer to as 'task crafting', which involves adding or dropping tasks, adjusting the time spent on a task and redesigning aspects of the task.

This study specifically investigates how employees utilise aspects of their job design, which are constrained by lean manufacturing principles, to actively widen the availability of resources and challenges within their job and reduce their exposure to job demands. The provision of these predetermined job characteristics (i.e. skill utilisation, felt accountability and problem solving demands) serve as stimulus cues for employees regarding whether it is legitimate for them to actively shape their jobs in various ways (Salancik & Pfeffer, 1978). Employees read cues regarding the physical boundaries of their jobs and respond accordingly, either by altering these boundaries or remaining a passive incumbent of the job role. For example, Petrou et al. (2012) found that the combination of high work pressure and high autonomy (i.e. active jobs) at the daily level was associated with increased levels of seeking resources and decreased levels of reducing demands. Tims et al. (2013) also found that employee crafting of structural and social job resources led to an increase in perceived structural (e.g. autonomy) and social (e.g. support) resources over a two month period. Similarly, Leana et al. (2009) found that work discretion was positively related to individual job crafting for teachers and their aides. The present study focuses specifically on the role of day-level job resources (i.e. skill utilisation), day-level job demands (i.e. felt accountability) and day-level job challenges (i.e. problem solving) as facilitators of daily job crafting activities. Differentiations between job resources and demands (Bakker & Demerouti, 2007; Halbesleben, 2010) and more recently between job demands and challenges (Crawford et al., 2010; Van den Broeck et al., 2010) have been empirically validated within the JD-R literature.

Skill utilisation refers to the opportunity to learn and apply skills on the job, and its benefits as a job resource for employees are well documented in terms of both well-being and performance (e.g. Humphrys & O' Brien, 1986; Wall et al., 1992). Employees working under lean manufacturing are believed to use a broader variety of skills over those using traditional manufacturing methods through their involvement in activities such as job rotation, cross-training and problem solving (Adler, 1990; Cullinane et al., 2013; Jackson & Mullarkey, 2000). The promotion of continuous learning within lean organisations is reinforced through the relationships between managers, supervisors and employees which encourage employees to use their skills to make decisions on their own (Adler, 1990). The degree to which an employee can utilise their skills on the job typically goes hand in hand with the level of control they have over their tasks (Warr, 1989). For example, when an employee has the freedom to make choices relating to the timing or methods used in their work, it allows them to draw on their existing knowledge as they determine each decision (Morrison, Cordery, Girardi & Payne, 2005). Similar to job control and discretion, which have been identified as facilitators of crafting behaviour (Leana et al., 2009; Wrzesniewski & Dutton, 2001), the degree to which an employee can utilise and develop their skills while working enhances their likelihood to seek opportunities to further enhance their learning capabilities (e.g. seeking advice and feedback). In addition, the COR theory (Hobfoll, 1989) claims that individuals with greater resources have greater capability to orchestrate resource gain. Therefore, based on the above evidence, it is predicted that employees will seek out further resources at work such as opportunities to learn new skills or seek advice on days when they are more fully utilising their skills at work. Specifically, the following is hypothesised:

Hypothesis 1: Day-level skill utilisation is positively related to day-level seeking resources by employees.

Problem solving demands are prevalent for employees under lean manufacturing due to process uncertainty arising from the absence of in-process inventory, variation in human performance and machine unreliability (Jackson & Mullarkey, 2000). Working in a lean environment requires an 'active problem solving orientation' to ensure the prevention of, and recovery from, errors in the production process (Wall et al., 1990). Therefore, problem solving is considered more as an active and cognitive demand than other typical lean demands such as monitoring and production pace (Jackson et al., 1993). Due to its cognitive nature, problem solving has both demanding and satisfying attributes (Morgeson & Humphrey, 2008; Wall et al., 1990). Similarly challenging demands (e.g. responsibility) have also been shown to trigger cognitions which result in active, problem-focused coping styles, well-being, and satisfaction (Crawford et al., 2010; LePine, Podsakoff & LePine, 2005). These demands yield opportunities for growth and development, which stimulate employees to exert effort in their job (Van den Broeck et al., 2010). On the basis of the COR theory (Hobfoll, 1989), it is also likely that challenges which are successfully met are considered to be non-threatening, therefore conserving the necessary resources required to seek out further challenges. Considering the existing evidence regarding the impact of job challenges, it is predicted that employees will seek out further challenges at work such as additional tasks and responsibilities on days when they are confronted with problem solving demands.

Hypothesis 2: Day-level problem solving is positively related to day-level seeking challenges by employees.

A frequent criticism of lean manufacturing concerns its use of team-working practices in creating a culture of peer surveillance and pressure (Sewell & Wilkinson, 1992; Turnbull, 1988). Mechanisms of quality control and feedback utilised within lean teams are often believed to intensify individual accountability and contribute to a 'blame' culture when defects are detected (Conti et al., 2006; Delbridge & Turnbull, 1992). Felt accountability refers to the expectation that an individuals' decisions or actions will be evaluated by oneself and others and either rewarded or sanctioned on this basis (Hall et al., 2006). Although accountability has, on occasion, been considered a potential positive resource for employees in minimising stress and improving organisational commitment, numerous studies have demonstrated the negative consequences of felt accountability for employees such as exhaustion and tension, and have identified it as an influential job demand (e.g. Hall et al., 2006; Royle et al., 2005). From the findings of a multi-industry study on employee stress in lean organisations, Conti et al. (2006) also identified blame for defects as a major stressor under lean manufacturing. Under conditions whereby demands exceed employee capability, they may experience accountability as a threat and react through forms of dysfunctional behaviours (Schlenker, Weigold & Doherty, 1991). Considering that the experience of role overload and/or conflict can result from the threat of accountability (Katz & Kahn, 1978), this perceived loss of resources (e.g. flexibility, role clarity) is believed to evoke avoidance and loss prevention strategies by employees (Gorgievski & Hobfoll, 2008). Based on the above evidence, it is predicted that on days when employees feel under scrutiny regarding their actions or decisions, they are more likely to engage in activities which reduce the demands of their work. Specifically, the following is hypothesised:

Hypothesis 3: Day-level felt accountability is positively related to day-level reducing demands by employees.

4.3 Job Crafting and Work Engagement

Engagement does not just "happen" to employees; rather employees have the ability to actively create engagement experiences (Salanova et al., 2010; Sonnentag et al., 2010). Employees are likely to revise their jobs in ways that fit their work orientation to create meaning in their job and identify with their work (Wrzesniewski & Dutton, 2001). Through job crafting, employees utilise often-hidden degrees of freedom in their job to customise it to fit to their own sense of what the job should be. Individuals who alter their work environment in order to align their job demands and resources with their own abilities and needs, have been found to facilitate their personal work engagement (Bakker et al., 2012; Tims & Bakker, 2010). Therefore, on the basis of person-environment fit theory (Edwards, 2008), this congruence between needs and environment achieved through crafting is expected to promote employees' engagement at work. Bakker et al. (2012) for example, found job crafting (as indicated by increasing structural and social resources and challenge demands) to predict both work engagement and in-role performance. Further analysis demonstrated that increasing structural resources was the strongest of the crafting dimensions in predicting these positive outcomes. Nielsen and Abildgaard (2012) found that crafting behaviours relating to increasing challenges, increasing social resources and increasing quantitative demands were positively associated with well-being (i.e. job satisfaction and work engagement) and negatively associated with ill-health (i.e. burnout). Decreasing demands however was unrelated to well-being outcomes and was therefore believed to be an avoidance coping strategy rather than a proactive behaviour. These findings indicate that when employees adapt their job to make it more resourceful and challenging (e.g. creating opportunities for learning and development, taking on interesting projects), they cultivate greater meaning from their work and are therefore more engaged. In addition, a number of authors have established a positive relationship between proactive behaviours such as job crafting, personal initiative, feedback-seeking and self-development, and positive outcomes such as work engagement and positive emotion (Anseel et al., 2013; Bakker et al., 2012; Hyvonen et al., 2009; Ko, 2012; Tims et al., 2013). In terms of evidence regarding the relationship between daily job crafting and daily engagement, Petrou et al. (2012) found a significant positive relationship between day-level seeking challenges and day-level work engagement and a significant negative relationship between day-level reducing demands and day-level work engagement. Therefore, in contrast to the non-significant findings of Nielsen and Abildgaard (2012) regarding the impact of reducing demands and work engagement at the general-level, these authors found that the dysfunctional effects of reducing demands are more prominent at the daily level. Although no relationship was found between seeking resources and work engagement at the day-level, these variables were highly correlated at the person level of analysis. Based on the above evidence the following hypothesis is proposed:

Hypothesis 4: (a) Day-level seeking resources and (b) day-level seeking challenges are positively related to day-level work engagement, and (c) day-level reducing demands is negatively related to day-level work engagement.

4.4 Task Interdependency and Job Crafting

Under lean manufacturing, the shop floor is organised into interdependent multi-disciplinary production units whereby all employee activity within the production cell is oriented toward a single product or family of products. As a result, employees under lean manufacturing are dependent on their co-workers' skill and manpower for the execution of their tasks (Klein, 1991). Wrzesniewski and Dutton (2001) propose that in jobs characterised by high levels of task interdependency, employees are strongly tied to the timing and tasks of others, thus diminishing their opportunities to engage in job crafting. These authors argue that task interdependency limits the level of control employees have over their work and inhibits their attempts to improve their job. Therefore, jobs which require little task interdependence provide greater latitude to alter task and relational aspects of the job as employees are not concerned that any modifications to their own work activity will disrupt the tasks of their co-workers. Similarly, Leana et al. (2009) predicted that task interdependency would be negatively associated with individual job crafting, although this was unsupported by their findings. Task interdependency has been previously identified as an important moderator in the prediction of employee outcomes in that it strengthens the dysfunctional effects of counter-productive work behaviour on well-being and reduces the positive effects of autonomy on motivation (Aube, Rousseau, Mama & Morin, 2009; Janz et al., 1997). A 'Catch-22' scenario develops in teams where both autonomy and interdependency are high whereby interdependencies amongst co-workers undermine individual autonomy (Janz et al., 1997). This study proposes that the proximal antecedents of expansive daily job crafting behaviour (i.e. day-level skill utilisation and day-level problem solving) will interact with the perceived level of general task interdependency amongst co-workers. In other words, it is expected that employees are more likely to utilise their resources and challenges on a daily basis to engage in positive crafting behaviour when the general levels of task interdependence within their team is perceived to be low compared to when it is perceived to be high.

Hypothesis 5: The relationship between day-level skill utilisation and day-level seeking resources is moderated by general-level task interdependence whereby skill utilisation is positively related with seeking resources at the daily level when the general-level of task interdependency is perceived to be low rather than high.

Hypothesis 6: The relationship between day-level problem solving and day-level seeking challenges is moderated by general-level task interdependence whereby problem solving is positively related with seeking challenges at the daily level when the general-level of task interdependency is perceived to be low rather than high.

4.5 Method

4.5.1 Participants

The study was conducted in 2012 in the Irish subsidiary of a large European multinational which operates as part of the manufacturing arm of their pharmaceutical division and employs approximately 390 people. Lean manufacturing was first introduced to the organisation in 2003 with the goal of sustainable reductions in cycle time, inventories, and costs. Extensive implementation of core lean manufacturing practices including supplier feedback and development, customer involvement, set-up reduction, preventative equipment maintenance, employee involvement and continuous flow (Shah & Ward, 2007) were reported at the time of data collection by the organisation's Head of Automation. The organisational structure had also been modified to complement the use of lean management whereby a flat, cross-functional structure with only three hierarchical layers (as opposed to the previous structure of six layers) was established. All organisational functions (e.g. manufacturing, quality assurance, maintenance) which were traditionally silo-based, were now integrated within larger cross-functional process units which operate autonomously either as an individual line or a number of manufacturing lines. The diary study was administered to the employees within a single production unit of the organisation. Within the production unit all 168 employees, from both operating and support teams, were asked to participate in the study. Members of the operating teams work shifts which consist of two twelve hour day shifts followed consecutively by two twelve hour night shifts. Members of the support team work from nine until five o' clock, Monday to Friday.

Meetings were held with participants at the beginning of their shift cycle/working week to provide them with information about the study, request participation and administer the general survey. Participants were instructed to complete a general survey on the first day of their shift/week and a daily survey at the end of each twelve hour shift or day of work. The author administered the daily surveys in person to employees towards the end of each shift/day to ensure that responses were based on that particular day, requesting that the completed surveys are left in a collection box before going home. To encourage participation a feedback report of the study and a lottery prize was offered to employees. Participants were asked to identify a self-generated code in order to match their general and daily surveys. 106 employees participated in the study in total (response rate of 63%), however only 64 of these included both the general survey and a minimum of one daily survey (response rate of 38%). In total, 86 general surveys and 204 daily surveys were completed. Participants provided on average 2.31 days (range: 1-5) with complete data from both surveys. Respondents were predominantly male (98%). Among these employees, 33% had worked for the organisation for less than three years, 25% between four and eight years, and 42% for more than nine years. 75% of respondents worked shifts while 25% worked days (i.e. Monday to Friday). 82% of respondents were members of the operating team while the remaining 18% were members of the support team (e.g. engineers, process managers, quality support etc.). As there was a large drop out between the general survey and the diary surveys, a drop out analysis was executed. All participants who completed the general survey were split into two groups: those who completed at least one daily survey and those who did not complete any daily surveys. A one-way ANOVA demonstrated that no significant differences existed between the two groups in terms of their general levels of work engagement (F (1, 182) =

1.584, $p = 0.21$). An additional indicator of the sample's representativeness is that it did not differ significantly from the total population of the production unit in terms of gender (85% male) and position (66% operating team, 33% support team).

4.5.2 General Questionnaire

In the general questionnaire, respondents provided demographics (gender, age, tenure, worker type, position, status and ID code) and information on their general levels of work engagement and task interdependency.

4.5.2.1 General Level of Work Engagement. Work engagement was measured using the vigour (3 items) and dedication (3 items) subscales (representing 'core engagement'; Demerouti et al., 2010) from the shortened version of the Utrecht Work Engagement Scale (UWES; Schaufeli et al., 2006). Example statements include "At work I feel bursting with energy" and "I am proud of the work that I do". Responses were on a 7-point frequency scale from 1 (Never) to 7 (Always/Everyday). Cronbach's alpha was .90.

4.5.2.2 General Level of Task Interdependency. Task interdependency was measured using a 3-item subscale from Campion and colleagues Work Group Characteristic Measure (1993). An example statement is "I cannot get task done without information from other team members". Responses were on a 7-point Likert scale from 1 (Strongly disagree) to 7 (Strongly agree). Cronbach's alpha was .74.

4.5.3 Daily Diary

The daily survey measured levels of job resources, challenges and demands, job crafting and work engagement on a specific day. All day-level measures were rated on a 7-point scale from 1 (Strongly disagree) to 7 (Strongly agree). Given that the number of items are limited within diary surveys, a minimum of three items were selected from the original scales based on face validity and from the items which demonstrated the highest factor loadings on their respective factors in previous studies within this context.

4.5.3.1 Day-Level Job Design. *Day-level skill utilisation* was measured using 3 items (Jackson & Mullarkey, 2000). An example is “Today I made full use of my skills”. Cronbach’s alpha ranged from .82 to .90. *Day-level felt accountability* was measured using 3 items (Hochwarter et al., 2003). An example is “Today I was held accountable for all my actions at work”. Cronbach’s alpha ranged from .64 to.83. *Day-level problem solving* was measured using 3 items (Jackson et al., 1993; Wall et al., 1995). An example is “Today I was required to deal with problems which were difficult to solve” Cronbach’s alpha ranged from .65 to .75.

4.5.3.2 Day-Level Job Crafting. The day-level versions of the three job crafting subscales were used to measure daily job crafting (Petrou et al., 2012; Tims et al., 2012). Day-level seeking resources included three items (e.g. “Today I asked colleagues for advice”) and Cronbach’s alpha ranged from .66 to .80. Day-level seeking challenges included three items (e.g. “Today I asked for more tasks if I finished my work”) and Cronbach’s alpha ranged from .87 to .95. Day-level reducing demands included three items (e.g. “Today I tried to simplify the complexity of my tasks at work”) and Cronbach’s alphas ranged from .53 to .93.

4.5.3.3 Day-Level Work Engagement. Day-level work engagement was measured using four items from the UWES (Schaufeli et al., 2006), two items representing day-level vigour (e.g. “When I got up today, I felt like going to work”), and two items representing day-level dedication (e.g. “Today I was proud of the work that I did”). Evidence exists to support claims that the UWES is a valid tool to measure both state (daily) and trait work engagement (Breevaart, Bakker, Demerouti & Hetland, 2012). Cronbach’s alpha ranged from .69 to .86.

4.5.4 Analysis

Data existed at two levels, the person level (level 2) and the day-level (level 1), whereby day-level data were nested within individual persons (Mok, 1995). To test the hypotheses, multilevel structural equation modelling (MSEM) was conducted using the Mplus statistical package (version 6.12; Muthén & Muthén, 1998-2010) using the maximum-likelihood method of estimation (Bollen, 1989). MSEM combines structural equation modelling with the analysis of hierarchical data and therefore facilitates the development of SEM models at each level of nesting for clustered data (Kaplan & Elliot, 1997; Mehta & Neale, 2005; Muthén & Satorra, 1995). This type of analysis allows for missing data which includes an unequal number of observations per day and an unequal number of days per individual (Mehta & Neale, 2005). Prior to testing the hypotheses, the variance attributed to the two-levels of analysis was examined by calculating the intra-class correlation coefficient for job crafting and work engagement. Intra-class correlation showed that 58% of the variance in reducing demands, 70% of the variance in seeking resources, 73% of the variance in seeking challenges and 78% of the variance in work engagement was attributable to between-person variations. Therefore significant amounts of variance were left unexplained by within-person variation which justifies the use of a multilevel approach.

General level work engagement, job tenure and worker type (i.e. day vs. shift work) were specified as between-level variables. Job design (i.e. skill utilisation, felt accountability and problem solving demands) and job crafting (i.e. seeking resources, seeking challenges and reducing demands) variables were specified as within-level variables. Day-level work engagement was not specified as it was modelled at both levels. General levels of work engagement, tenure and worker type were controlled for in the analysis, allowing for the examination of day-level relationships after taking the individual's general tendency to feel engaged at work, their length of service within the organisation and their job role into account. Paths between day-level variables (i.e. from day-level job characteristics to day-level job crafting) were modelled at the within level of the model. All possible relationships between daily job characteristics (i.e. skill utilisation, problem solving and felt accountability) and dimensions of daily job crafting (i.e. seeking resources, seeking challenges and reducing demands) were examined in the model in order to detect any potential cross-linkages. Paths from between-level variables (tenure, worker type and general work engagement) to within-level work engagement were modelled at the between level. Predictor job design variables at the within-level (i.e. skill utilisation, felt accountability, problem solving demands) were centred around the person mean and general-level explanatory variables (general work engagement) were centred around the sample mean. Day-level predictor variables were centred around the person mean to ensure that the between-person differences were removed and therefore leaving only a “pure” estimate of the pooled within-cluster regression coefficient (Enders & Tofighi, 2007).

4.6 Results

4.6.1 Descriptive Statistics

Means, standard deviations and correlations are displayed in Table 4.1. In order to calculate correlations between day-level and general-level variables, the day-level variables were averaged across all days. As general-level task interdependence and general-level work engagement were measured at the between level (i.e. person level), correlations with those variables cannot be interpreted in the usual way, but are included for the sake of completeness in the table.

Table 4.1 Descriptive Statistics and Correlations between Variables of Study 3

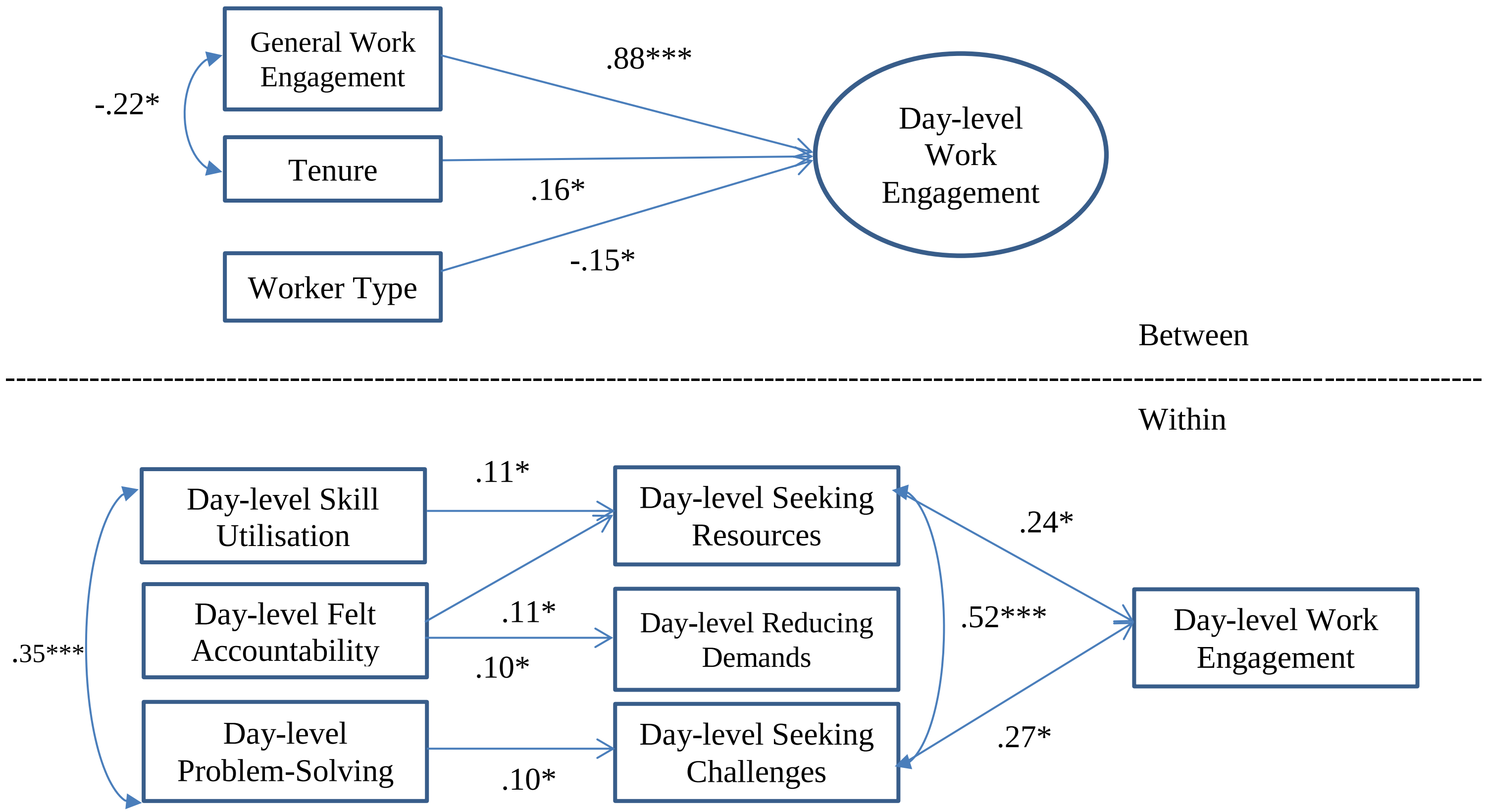
	Mean	SD	1	2	3	4	5	6	7	8	9	10	11
1. Worker Type	NA	NA	1										
2. Tenure	3.18	1.41	.310**	1									
3. General Work Engagement	5.05	1.03	.004	-.224**	1								
4. General Task Interdependence	5.60	0.82	-.067	-.281**	.150*	1							
5. Day-level Skill Utilisation	4.67	1.38	.150	-.104	.533**	.080	1						
6. Day-level Felt Accountability	4.70	1.21	.121	-.048	.359**	.307**	.408**	1					
7. Day-level Problem Solving	4.11	1.36	-.384**	-.394**	.131	.237**	.450**	.328**	1				
8. Day-level Seeking Resources	4.08	1.31	-.132	-.410**	.445**	.395**	.364**	.314**	.315**	1			
9. Day-level Reducing Demands	4.39	1.17	.191*	.243**	.241**	.084	.585**	.323**	.373**	.168*	1		
10. Day-level Seeking Challenges	3.19	1.61	-.020	-.266**	.326**	.192*	.166	.075	.159*	.645**	.104	1	
11. Day-level Work Engagement	4.92	1.14	-.041	-.150	.826**	.137	.597**	.455**	.222*	.565**	.275**	.381**	1

Note: Aggregate scores were used for day-level data (i.e. a mean score of their total number of participation days).
*p < 0.05, **p < 0.01

4.6.2 Test of the Hypothesised Direct Model

The hypothesised MSEM (see Figure 4.1) displayed excellent fit to the data (Figure 1); χ^2 /*df* = 1.27, RMSEA = 0.041, SRMR = 0.028 (within level) and 0.031 (between level), CFI = 0.98, TLI = 0.95. As predicted, the highest levels of seeking resources occurred on days when skill utilisation was high ($\beta = 0.11$, $p < .05$), the highest levels of seeking challenges occurred on days when problem solving demands were high ($\beta = 0.10$, $p < .05$) and the highest levels of reducing demands occurred on days when felt accountability was high ($\beta = 0.10$, $p < .05$). Thus Hypotheses 1-3 were confirmed. Unexpectedly, day-level accountability was also positively associated with day-level seeking resources ($\beta = 0.11$, $p < .05$). In terms of the relationship between daily job crafting and work engagement, both day-level seeking resources ($\beta = 0.24$, $p < .05$) and day-level seeking challenges ($\beta = 0.27$, $p < .005$) were positively associated with day-level work engagement which supports both Hypothesis 4a and 4b. Day-level reducing demands did not have a significant impact on day-level work engagement, therefore Hypothesis 4c was not supported.

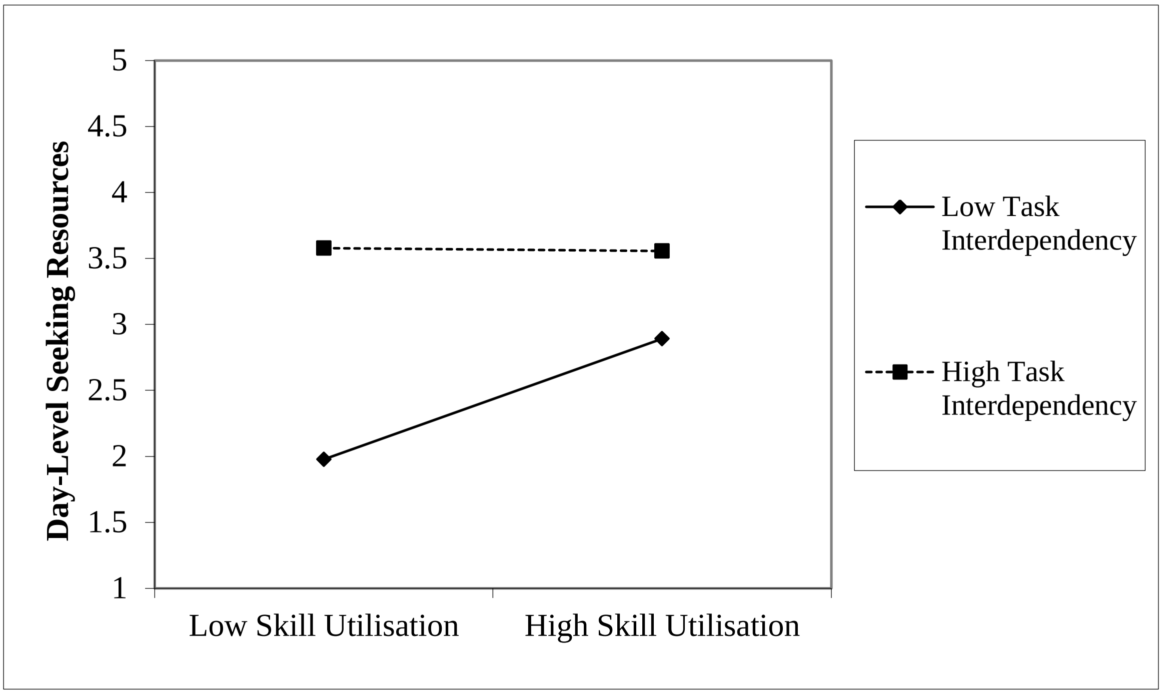
Figure 4.1 Results of Multi-Level Structural Equation Modelling



4.6.3 Test of the Cross-Level Moderation Model

In the cross-level moderation model, the random slopes of the job design-job crafting relationships (e.g. skill utilisation-seeking resources) were regressed on general level task interdependency. In testing the cross-level interaction Level 1 predictor variables (i.e. skill utilisation and problem solving) were centered around the person mean to improve the interpretation of the cross-level interaction effect (Aguinis et al., 2013). As expected (Hypothesis 5), the results suggest that the relationship between day-level skill utilisation and day-level seeking resources (γ = -.23, p<.05) is stronger when task interdependency at the general level is perceived to be low rather than high. Contrary to expectations (Hypothesis 6) task interdependency at the general level was not found to be a significant moderator of the problem solving/seeking challenges relationship. To further evaluate the significant interaction between day-level skill utilisation and general-level task interdependency the interaction was plotted following the procedure illustrated by Aiken and West (1991) which is deemed appropriate for examining cross-level interactions (Dawson, 2013). This result is shown graphically in Figure 4.2.

Figure 4.2 Cross-level Moderation of General Level Task Interdependency in the Skill Utilisation-Seeking Resources Relationship



4.7 Discussion

Our aim in the present study was to determine whether, on a daily basis, jobs designed according to lean manufacturing principles facilitate daily job crafting, and whether job crafting behaviour facilitates work engagement for employees. Results from MSEM indicate that, in line with the hypotheses, each of the three daily job characteristics associated with lean manufacturing uniquely impacts the daily crafting of jobs by employees. First, in a similar fashion to work discretion and autonomy (Leana et al., 2009), perceived high levels of daily skill utilisation (i.e. job resources) were found to encourage employees to enhance their job on that day by seeking further resources such as learning new things or gaining advice. Second, the findings show that employees who experienced heightened problem solving demands (i.e. job challenges) on a given day were encouraged to increase the level of challenge in their work by asking for additional tasks or responsibilities. Therefore, the claim that job challenges (as opposed to job demands) stimulate employees to put more effort in their job as they provide opportunities for growth and development is supported (Van den Broeck et al., 2010). Third, in line with research which identifies felt accountability as a job hindrance (Conti et al., 2006; Hall et al., 2006), the degree to which employees felt they would be held accountable for their decisions and actions on a particular day (i.e. job demands) was found to increase their likelihood to simplify and reduce the intensity of their work. This finding also supports claims of the COR theory that employees will respond to perceived threats by trying to avoid them or prevent them from reoccurring (Hobfoll, 1989). The unexpected positive relationship found between felt accountability and seeking resources differs from existing predictions that visibility acts as a deterrent for employees to engage in job crafting (Berg et al., 2010). This, however, can be explained by the potential for employees to engage in proactive behaviours when they believe that their actions will be scrutinised by their colleagues. If employees are dependent on one another's manpower and skill to complete their tasks, pressure on individuals to seek feedback and advice and broaden one's skills will be heightened. Drawing also on the COR theory (Hobfoll, 1989), it is also possible that employees who feel threatened by their accountability at work try to increase their resources as a coping mechanism.

In addition to demonstrating the role of daily job characteristics as facilitators of daily crafting activities, this is the first study to examine the role of task interdependence in preventing employees' use of daily resources to alter or modify their job. Specifically, it was found that an employee's use of their skills on a given day only encourages them to further increase their job resources when they are not dependent on their colleagues to complete their tasks (i.e. they work independently). By changing the task boundaries of their job, employees within interdependent teams are further changing the tasks of those dependent on them to carry out their work. In line with previous research which identifies task interdependency as an inhibitor of job crafting (Wrzesniewski & Dutton, 2001) and a moderator which reduces the beneficial impact of job characteristics (Janz et al., 1997), this study found that only employees who work somewhat independently can utilise their job resources to further enhance their job through crafting. Therefore, in confirming this cross-level interaction we broaden our understanding of how opportunities for employees to craft their job are diminished by high levels of interdependency.

Furthermore, considering the daily relationship between job crafting and work engagement, the findings support previous studies which found that employees facilitate their own engagement by mobilising their own resources and setting their own challenges (Bakker et al., 2012; Nielsen & Abildgaard, 2012; Petrou et al., 2012). However, contrary to the findings of Petrou and colleagues (2012), a positive relationship was found between day-level seeking resources and daily work engagement. As these authors found significant correlations between seeking resources and work engagement at the between-level yet not at the within-level, the difference between our results can be explained by the degree to which employees in each sample are presented with opportunities each day to ask for advice or learn new things. Employees under lean manufacturing have high levels of social interaction within teams (Jackson & Mullarkey, 2000), which provides more opportunities for seeking resources on a daily basis which are social in nature. The findings of this study demonstrate the relationship between both daily seeking challenges and seeking resources and daily work engagement. Contrary to expectation, yet similar to Tims et al. (2013), no relationship was found between reducing demands and work engagement. Mean levels of day-level reducing demands were the highest of all crafting dimensions (4.39), demonstrating that employees reduced their job demands on a daily basis. It is therefore likely that the processes underlying crafting behaviours which are oriented toward role expansion, and those oriented toward narrowing the role, differ in nature. Reducing the demands of one’s job is perhaps a more dysfunctional characteristic of job crafting (Oldham & Hackman, 2010), and is therefore more likely to lead to detached work-related states such as cynicism or boredom which could potentially lead to higher absenteeism or inefficiencies in the work process.

4.8 Limitations and Future Research

Although this study has numerous contributions, its limitations must also be noted. First, all data for this study was collected using self-report methods. Although the use of self-report is more appropriate for assessing perceptions of the job and employee well-being (Sousa-Poza & Sousa-Poza, 2000), future research would benefit from assessing job crafting using both individual and peer ratings. In such interdependent contexts as lean manufacturing where employees work very closely with one another on a daily basis, an individual's willingness to engage in proactive crafting behaviours would be highly visible to their colleagues. Second, although this study has identified how daily job design, crafting and engagement are related, no conclusions about causality can be drawn from these findings. Future research should consider a longitudinal replication of the hypothesised relationships to examine potential reciprocal relationships within the model and the potential mediating role of job crafting in the daily relationship between job design and work engagement. For example, Tims et al. (2013) recently found that employees who crafted their job resources showed an increase in their structural and social resources over a two month period. A reciprocal relationship has also been proposed between job crafting and engagement, whereby in addition to the presented finding that employees who craft their job facilitate their own engagement, it is also proposed that employees who are engaged are more likely to proactively craft their job (Bakker, 2011). Therefore longitudinal research, with longer time intervals allowing for employees to alter their job characteristics, would be beneficial to test the interrelationships and potential mediations within the proposed model.

Another potential avenue for future research is to examine the dysfunctional role of job crafting. Our understanding of reducing demands and its impact on employee outcomes remains limited following a number of non-significant findings, including the present study, with regard to work engagement, job satisfaction and burnout (e.g. Nielsen & Abildgaard, 2012; Tims et al., 2013). Although reducing demands was found to be negatively related to daily work engagement (Petrou et al., 2012) and vigour (Tims, Bakker & Derks, in press) and positively related to cynicism (Tims et al., 2012), these findings have not been consistent across studies. Therefore, there is a need for research which exclusively identifies the psychosocial antecedents and outcomes of reducing demands for employees. This would deepen our understanding of why employees feel the need to narrow their job role, and how they subsequently experience their work once their demands are reduced. In addition, future research should consider recent evidence which shows that job crafting is both an individual and team level phenomenon (Leana et al., 2009; Tims, Bakker, Derks & Van Rhenen, in press). This study has demonstrated how team characteristics (i.e. task interdependence) inhibit the facilitation of individual crafting, as employees are reluctant to use their resources to make individual changes to their work when it also impacts the work of colleagues dependent on them. Leana and colleagues (2009), however, found that task interdependency was positively related to collaborative job crafting, where employees determine together how they can alter their work to meet their shared work goals. Therefore future research, which addresses interdependent contexts such as lean manufacturing, should consider how employees combine their efforts to increase resources and challenges and reduce demands as a team process.

4.9 Conclusion

The present study demonstrated that (a) jobs designed on a daily basis according to lean principles (providing high skill utilisation, problem solving and accountability) facilitate daily job crafting activities, and that (b) expansive job crafting activities lead to high levels of daily employee engagement. Overall, the motivational benefits of job crafting revealed by the findings show how imperative it is for managers to ensure that certain job characteristics are reinforced each day. This in turn will provide cues for employees to adapt their resources and challenges as required. Future research is encouraged to further examine ways in which crafting can be encouraged, and in doing so, recognise the importance of context in identifying its main antecedents and outcomes.

Chapter Five

Discussion and Conclusions

5.1 Introduction

The primary objective of this thesis was to formulate and test a model through which job design under lean manufacturing impacts employee well-being. From this, a number of research questions arose. In this chapter the answers to these questions are discussed in light of the results obtained from the three studies presented. Following this, the theoretical implications and overall contributions of the research are presented. The limitations of the studies are then outlined and recommendations are provided for future research in the area. Finally, a number of practical recommendations which stem from the three studies are outlined.

Question 1: *How are jobs designed under lean manufacturing?*

The inconsistent findings across existing studies which examine the quality of working life under lean manufacturing are partly attributable to the use of context-free job design models such as the JD-C (Karasek, 1979) and the JCM (Hackman & Oldham, 1976). With the aim of tailoring a model of job design to specifically capture the context of lean manufacturing and its subsequent implications for employees, this thesis adapts the JD-R model (Demerouti et al., 2001) in order to identify the job resources and job demands salient to this unique work environment. In the first study, the prominent lean-specific job characteristics were identified from previous research addressing working conditions within this context. These lean-specific job characteristics were then categorised as job resources (task, social and knowledge), job demands and job challenges. These categories of job characteristics were identified on the basis of the JD-R model and recent developments of the JCM (Campion et al., 2005; Morgeson & Humphrey, 2008).

Building on the first study, the second study also identified a number of these job resources (boundary control and feedback) and demands (production pace and problem solving) as salient within the lean manufacturing context. In addition, based on exploratory data collection with employees from the case site, this study considered training as a lean-specific resource and task interdependency and felt accountability as lean-specific demands. The differentiation between job resources and demands within this context was supported by confirmatory factor analysis (CFA). The CFA results demonstrated that these two dimensions of job design displayed superior fit to the data than a one-dimensional structure or a three-dimensional structure whereby job demands and challenges were also differentiated (e.g. problem solving as a job challenge). Therefore, the differentiation between job demands and job challenges, as found in previous studies (Crawford et al., 2010; Van den Broeck et al., 2010) and as outlined in Study 1, was not supported by the data in Study 2. This indicates that demands of a challenging or more cognitive nature, or what MacDuffie (1995) termed as 'thinking work', are equally perceived as psychological costs for employees within this context. The differentiation between demands perceived as hindrances and demands perceived as challenges may only become apparent in specific job roles or amongst employees with high levels of education and skill and who are qualified to deal with and master production problems (Demerouti & Bakker, 2011; Folkman, Lazarus, Gruen & DeLongis, 1986; LePine et al., 2005; Ohly & Fritz, 2009). Therefore, the potential boundary conditions which determine the appraisal of demands requires further exploration.

The third and final study differentiated between lean-specific job resources (skill utilisation), lean-specific job demands (felt accountability) and lean-specific job challenges (problem solving) encountered by employees at the daily level. This three-dimensional structure of daily job design was considered to complement the operationalisation of job crafting activities as oriented toward these three types of job characteristics (i.e. increasing resources, increasing challenges and reducing demands). Although a measurement model was not included in the analysis for this study, an exploratory factor analysis (EFA) was carried out in SPSS for the items of job design and then for the items of job crafting for each day of the study to confirm these differentiations. The results displayed a clean three factor solution for both job design (job resources, job demands and job challenges) and job crafting (seeking resources, seeking challenges and reducing demands) for each of the four days. These results, and the results of the ML-SEM which show the unique relationships between these three dimensions of daily job design and the three dimensions of daily job crafting, support the three-dimensional structure of job design within this context at the daily level. As the differentiation between job demands and challenges was more apparent at the daily level, it is possible that characteristics such as problem solving are perceived as a challenge in the short term, but as a demand or a cost in the long term. Although there is no empirical evidence, to the author's knowledge, which demonstrates differences in the appraisal of chronic and temporal demands, there is evidence to suggest that coping and regulation processes are apparent at a daily level (Ohly & Fritz, 2010; Schmitt, Zacher & Frese, 2012). Ohly and Fritz (2010) for example, suggest that individuals who desire changes in their work conditions might appraise their situation as challenging at that time. Therefore, the appraisal of demands such as problem solving, which is already considered to be a 'double-edged sword for employees' (Humphrey et al., 2007), may differ across stable and daily work experiences.

Question 2: *How do lean-specific job resources impact employee well-being?*

The motivational process proposed by the JD-R model, and developments of the JCM, demonstrate the motivational potential of social, contextual, knowledge and physical characteristics (Grant et al., 2010b; Morgeson & Humphrey, 2008). Based on this conceptualisation, Study 1 and 2 of this thesis proposed and examined the relationships between lean-specific job resources and motivational outcomes (i.e. work engagement). Considering the existing evidence from studies examining lean manufacturing, the JD-R model and job design more generally, Study 1 proposed that the task resources (control and performance feedback), knowledge resources (skill utilisation, variety and development) and social resources (interaction and support) associated with lean manufacturing principles will increase motivational outcomes. Study 2 tested this motivational process by examining the relationship between lean-specific resources (as indicated by training, feedback and boundary control) and work engagement using cross-sectional data from a sample of 200 employees with extensive exposure to an array of lean practices. As predicted, lean-specific resources were positively associated with work engagement, and accounted for 24% of its variance. Similar to those who found similar cross-linkages within the JD-R model (e.g. Schaufeli & Bakker, 2004), lean-specific resources were also found to be negatively associated with exhaustion for employees. In addition to providing support for the JD-R model and the JCM, these findings also support previous research by demonstrating the beneficial role of job resources for reducing stress and improving satisfaction in the lean manufacturing context (Anderson-Connolly et al., 2002; Conti et al., 2006; Jackson & Mullarkey, 2000; Parker, 2003; Sprigg & Jackson, 2006). Study 2 extends these findings by demonstrating that these job resources play an influential dual role within this context as they simultaneously foster motivational outcomes while minimising negative health-related outcomes for employees.

Question 3: *How do lean-specific job demands impact employee well-being?*

The health-impairment process proposed by the JD-R model demonstrates the detrimental role of job demands for employees under lean manufacturing and this has been supported in numerous studies (e.g. Bakker et al., 2005; Bakker et al., 2004; Bakker et al., 2008). On this basis, Study 1 and 2 proposed and examined the relationships between lean-specific job demands and negative health-related outcomes (i.e. exhaustion). Although these health-impairing job characteristics were largely excluded from job design models until more recently (Grant et al., 2010a; Morgeson & Humphrey, 2008), meta-analytic results have demonstrated a positive relationship between physical demands and job strain, and a negative relationship between physical demands and job satisfaction (Humphrey et al., 2007). Study 1 proposed that job demands (work pace, physical demands and monitoring pressure) associated with lean manufacturing principles will increase negative health-related outcomes for employees. Study 2 empirically tested this health-impairment process by examining the relationship between lean-specific demands (as indicated by production pace, task interdependency, problem solving and accountability) and exhaustion using cross-sectional data from a sample of 200 employees with extensive exposure to an array of lean practices. As predicted, lean-specific demands were positively associated with exhaustion and were unrelated to work engagement. These findings provide support for both the JD-R model and for the recent addition of demands to the JCM. They are also in line with previous studies which demonstrate the strong role of demands in the deterioration of employee health under lean manufacturing (Anderson-Connolly et al., 2002; Conti et al., 2006; Jackson & Mullarkey, 2000; Parker, 2003). Furthermore, they add to the literature on lean manufacturing in demonstrating that that these demands are influential in leading to employee exhaustion, yet have no direct impact (negative or positive) on motivational outcomes for employees working in this particular context.

Question 4: *How does the interplay of job resources and job demands impact employee well-being under lean manufacturing?*

Although the previous two questions regarding the direct impact of lean-specific job design on employee well-being have already been assessed (see Hasle et al., 2012 for an overview), none of these studies have considered how these beneficial and damaging job characteristics interact with one another within this context. As a result, the contingent conditions under which lean-specific resources are motivational and lean-specific demands are harmful remain unknown. Based on the assumptions of the JD-R model, two potential interactions were examined in this thesis in the prediction of motivational and negative health-related outcomes for employees. First, on the basis of the COR theory (Hobfoll, 2002) and the strain and learning hypothesis of the JD-C model (Karasek & Theorell, 1990), Study 1 and 2 proposed and examined the buffering role of job resources in the relationship between job demands and negative health-related outcomes. Specifically, both studies predicted that lean-specific job resources moderate the positive relationship between lean-specific job demands and negative health-related outcomes (i.e. exhaustion), such that the relationship will be weakened given high rather than low lean-specific resources. Although this relationship was unsupported by the findings of Study 2, the effect was marginally significant and occurred in the expected direction. Shieh (2009) notes that moderator effects are particularly difficult to detect in observational studies with continuous variables as it is common for modest amounts of incremental variance to be explained by the interaction terms because the variance of the variables is typically restricted, skewed, or both. Therefore, this result indicates that the provision of lean-specific resources is likely to reduce the health-impairing potential of lean-specific demands for employees.

Second, based on more recent extensions of the JD-R model (Bakker et al., 2007; Hakanen et al., 2005), both studies considered an extension of the motivational process whereby lean-specific resources have a stronger relationship with motivational outcomes in the face of high lean-specific demands. This coping hypothesis suggests that job resources supply strategies for dealing with job demands and therefore have less motivational potential when job demands are absent (Bakker et al., 2007; Seers et al., 1983). This hypothesis was supported by the results of Study 2 which specifically found a significant positive effect of the latent interaction variable (resources x demands) on work engagement. To the author's knowledge, no empirical study which addressed the positive and negative characteristics of job design under lean manufacturing has yet addressed the interactive effects of these distinct job design characteristics in predicting employee psychosocial outcomes. Although lean-specific demands in isolation deplete the energy of employees, they act as motivational challenges which predict work engagement when combined with lean-specific resources. Therefore, where previous studies concluded that in order to promote a positive work environment demands should be minimised and resources maximised under lean manufacturing, this interaction adds a new layer of complexity to both the theoretical and practical implications of existing knowledge regarding the quality of working life in this context.

Question 5: *What characteristics of job design under lean manufacturing facilitate/inhibit employee job crafting behaviour?*

As previously outlined, decisions made by management regarding job design provide cues for employees regarding whether it is appropriate for them to make alterations to the boundaries of their job. These cues can either encourage employees to become an architect or a passive incumbent of their job role (Salancik & Pfeffer, 1978; Wrzesniewski & Dutton, 2001). Using a daily dairy study across four days with 64 employees, Study 3 assessed whether jobs designed on a daily basis according to lean manufacturing principles facilitate daily job crafting. Results from MSEM indicated that, in line with the presented hypotheses, each of the three daily job characteristics associated with lean manufacturing uniquely impacts the daily crafting of jobs by employees. First, in a similar fashion to work discretion and autonomy (Leana et al., 2009), this research found that perceived high levels of daily skill utilisation (i.e. job resources) encouraged employees to enhance their job on that day by seeking further resources such as learning new things or gaining advice. Second, the findings show that employees who experienced heightened problem solving demands (i.e. job challenges), on a given day, felt encouraged to increase the level of challenge in their work by asking for additional tasks or responsibilities. Therefore, the claim that job challenges (as opposed to job demands) stimulate employees to put more effort in their job as they provide opportunities for growth and development is supported (Van den Broeck et al., 2010). Third, in line with research which identifies felt accountability as a job hindrance (Conti et al., 2006; Hall et al., 2006), this research found that the degree to which employees felt they would be held accountable for their decisions and actions on a particular day (i.e. job demands) increased their likelihood to simplify and reduce the intensity of their work. This finding also supports claims of the COR theory that employees will respond to perceived threats of resource loss by trying to avoid them or prevent them from reoccurring (Hobfoll, 1989). The unexpected positive relationship found between felt accountability and seeking resources differs from existing predictions that visibility acts as a deterrent for employees to engage in job crafting (Berg et al., 2010). However, this can be explained by the potential for employees to engage in proactive behaviours when they believe that their actions will be scrutinised by their colleagues. If employees are dependent on one another's manpower and skill to complete their tasks, pressure on individuals to seek feedback and advice and broaden one's skills will be heightened. Drawing also on the COR theory (Hobfoll, 2002), it is also possible that employees who feel threatened by their accountability at work try to increase their resources as a coping mechanism.

In addition to demonstrating the role of daily job characteristics as facilitators of daily crafting activities, Study 3 is the first study to examine the moderating role of task interdependence in the relationship between job design and job crafting. Specifically, the results show that an employees' use of their skills on a given day only encourages them to craft their job (i.e. seeking resources) when they are not dependent on their colleagues to complete their tasks (i.e. they work independently). However, a similar hypothesis which predicted that task interdependency would also moderate the daily relationship between problem solving and seeking challenges was unsupported. By changing the task boundaries of their job, employees within interdependent teams are further changing the tasks of those dependent on them to carry out their work. In line with previous research which identifies task interdependency as an inhibitor of job crafting (Wrzesniewski & Dutton, 2001), and a moderator which reduces the beneficial impact of job characteristics (Janz et al., 1997), this study found that only employees who work somewhat independently can utilise their job resources to further enhance their job through crafting.

Question 6: *Do employees regularly craft their job under lean manufacturing to facilitate their personal engagement?*

Employees tend to revise their job in ways that fit their work orientation in order to create meaning in their job and identify with their work (Wrzesniewski & Dutton, 2001). Therefore, Study 3 examined the daily relationship between daily job crafting and daily work engagement. In particular, this study assessed how three job crafting behaviours (seeking resources, seeking challenges and reducing demands) carried out by employees on a given day uniquely influenced the degree to which employees are engaged on that day. The findings of this study support previous studies which found that employees facilitate their own engagement by mobilising their own resources and setting their own challenges (Bakker et al., 2012; Nielsen & Abildgaard, 2012; Petrou et al., 2012). Although Petrou and colleagues (2012) found significant correlations between seeking resources and work engagement at the between-level, they found no relationship between these variables at the within-level. In contrast, the results of the daily diary study presented here demonstrate a positive relationship between day-level seeking resources and daily work engagement. The difference between the results could be explained by the degree to which employees in each sample are presented with opportunities each day to ask for advice or learn new things. Employees under lean manufacturing have high levels of social interaction within teams (Jackson & Mullarkey, 2000). This provides more opportunities for seeking resources on a daily basis which are social in nature. The present findings therefore demonstrate that meaningful relationships exist between both daily seeking challenges and seeking resources and daily work engagement. Contrary to expectations, no significant relationship was found between reducing demands and work engagement. However, this is consistent with Tims and colleagues (2013) who also failed to find support for this relationship. As mean levels of day-level reducing demands were the highest of all crafting dimensions, it is evident that employees reduced their job demands on a daily basis. It is therefore likely that the processes underlying crafting behaviours which are oriented toward role expansion, and those oriented toward narrowing the role, differ in nature. Reducing the demands of one’s job is perhaps a more dysfunctional characteristic of job crafting (Oldham & Hackman, 2010), and is therefore more likely to lead to detached work-related states such as cynicism or boredom. Over time this could potentially lead to higher absenteeism or inefficiencies in the work process.

5.2 Research Contributions

This research offers a number of valuable contributions to the literature on lean manufacturing, job design and occupational health. First, although the JD-R model has frequently been used across a wide variety of contexts to examine the motivational and health-implications of particular jobs, no study to date has identified this framework as critical in terms of simultaneously capturing both positive and negative aspects of jobs designed under lean manufacturing. In adapting this framework to the lean manufacturing context, this research highlights the need to discriminate between its resultant job characteristics (i.e. resources, challenges and demands) and their unique roles in predicting motivational and health impairment outcomes for employees. The dual processes examined throughout this research incorporate and validate the claims of both critics and advocates, and help to explain the findings of recent studies which report both positive and negative outcomes of lean manufacturing for employees (Anderson-Connolly et al., 2002; Conti et al., 2006; Godard, 2001; Jackson & Mullarkey, 2000; Seppällä & Klemola, 2004). Furthermore, this is the first study to examine the interplay between positive and negative working conditions under lean manufacturing. The interactions found in Study 2 between lean-specific resources and demands, call into question the established perspective of lean-specific demands as solely damaging for the quality of working-life (e.g. Landsbergis et al., 1999). Instead it demonstrates how the job demands which employees in this context are exposed to can activate the motivational potential of the provided job resources.

Second, the use of a within-person design in Study 3 provides a novel insight into how an employee's experience of the lean working environment fluctuates on a daily basis. The examination of short term variations within the dynamic constructs of work engagement and job crafting facilitated measurements closer to the actual experience of employees within this context than the between-person approach adopted in Study 2 (Bolger et al., 2003; Ohly et al., 2010). The findings of Study 3 add to the scarce body of literature regarding contextual facilitators of job crafting by examining its relationship with previously unexamined job resources, demands and challenges encountered by employees under lean manufacturing. This study further examined and established, for the first time, the detrimental impact of high task interdependency in the relationship between job design and job crafting. In demonstrating this interactive relationship, Study 3 identifies task interdependency as a contextual constraint of individual job crafting within this context. In doing so, it also presents an optimal combination of job characteristics for encouraging employees to proactively redesign their jobs on a daily basis.

This research also offers some methodological contributions to both the lean manufacturing literature and the literature surrounding job design and occupational health. First, the use of SEM for the analysis of the hypothesised model in Study 2 is a novel contribution to the debate surrounding the quality of working life under lean manufacturing, as it allowed for the differentiation between lean-specific job characteristics (i.e. job resources and demands) and between motivational and health-related employee outcomes (i.e. work engagement and exhaustion) using CFA. The use of SEM also facilitated the simultaneous analysis of both motivational and health-impairment processes (Henseler, 2012; Oke, Ogunsami & Ogunlana, 2012), rather than separating the positive and negative effects as in previous research (e.g. Jackson & Mullarkey, 2000). Using moderated SEM, Study 2 further examined the interplay between the latent variables of job resources (as indicated by training, feedback and boundary control) and job demands (as indicated by production pace, task interdependency, problem solving and accountability). This innovative approach to examining moderation allowed for the examination of interactions between these latent manifestations of lean-specific resources and lean-specific demands, rather than examining the individual interactions between all indicators one by one.

Second, the use of ML-SEM in Study 3 allowed the author to simultaneously determine the unique impact of three dimensions of daily job design (i.e. job resources, challenges and demands) on job crafting activities. This approach further facilitated the modelling of paths between day-level variables at the within-level while also controlling for individual baselines of work engagement, job roles and tenure. This made it possible to examine, for the first time, why employees who are generally happy working in this environment may not be happy every day. Finally, the innovative use of ML-SEM to test the proposed cross-level interaction in Study 3 demonstrated a previously unexamined interplay between dynamic (skill utilisation and problem-solving) and stable (task interdependency) job characteristics as antecedents of daily employee behaviour.

Overall, this research moved us beyond the question as to whether lean has positive or negative effects, and toward an answer to the question of how to balance lean-resources and lean-demands to create jobs which are equally enriched and efficient. At a more general level, this research demonstrates the fundamental influence of context in determining job characteristics which impact the quality of working life for employees. As a result, it shows how contingent models of job design can be created to more accurately fit an organisational context.

5.3 Limitations and Future Research

Although the research carried out in this thesis provides novel insights into the complexities of job design under lean manufacturing and its relationship with employee well-being and job crafting behaviour, it is not without its limitations. First, as both Studies 2 and 3 used cross-sectional designs, conclusions about causality cannot be drawn from their findings. It is therefore advisable for future research examining the quality of working life under lean manufacturing to use a longitudinal examination of the hypothesised relationships. This would permit the inference of causality between lean job design, job crafting and employee well-being. A longitudinal design would also permit the examination of potential reverse causal effects, whereby employees who become more engaged in their work are more likely to craft their job (Bakker, 2011) and experience a subsequent increase in job resources or job challenges or a reduction in their job demands (Tims et al., 2013). Therefore, longitudinal research with intervals which allow sufficient time for employees to alter their job characteristics would be beneficial to test these interrelationships, and also to examine potential mediations across the models outlined in this thesis.

Second, very few studies have been able to infer clear and distinct causal relationships between objective lean manufacturing practices (e.g. statistical process control, total preventative maintenance), job characteristics and employee outcomes due to methodological limitations, namely small samples of organisations utilising these practices (Conti et al., 2006). Therefore much of the existing research, including the research conducted for this thesis, has used single organisations to examine the quality of working life under lean manufacturing. Hasle and colleagues (2012) recommend that future studies should be designed to examine the relations between the ten dimensions of lean manufacturing (outlined in Table 3.1; Shah & Ward, 2007) and the work environment. This calls for the use of multi-level or multi-group research designs, which examine the hypothesised relationships across organisations or units within organisations with varying levels of lean manufacturing usage. Multi-level design would also facilitate the inclusion of important contextual moderators such as the size and type of the organisation, the length of lean use, the pre-existing work design, and implementation methods (Conti et al., 2006; Hasle et al., 2012; Parker 2003). Furthermore, the assessment of lean practices using these ten dimensions, ideally carried out by expert raters, would also reduce the risk of common method bias in future studies. As all of the variables measured in Studies 2 and 3 in this thesis were completed by self-report, there is an increased risk of common method bias in the results. The use of self-report data is appropriate when examining perceptions of the job, personal well-being, and intentions to behave in a certain manner as they are within-person variables. Therefore, it is plausible to suggest that it is only individuals themselves who can rate these measures (Chan, 2009). However, future use of objective measures for lean manufacturing practices would strengthen the causal connection with employee outcomes, and reduce the risk of common method bias in the data. The use of this multi-level approach which objectively assesses lean usage would also facilitate the examination of both its employee level outcomes (e.g. job design and well-being) and organisational level outcomes (e.g. operational performance). Furthermore, it would shed light on whether the performance advantages of lean manufacturing are (a) gained at the expense of employee well-being (Bruno & Jordan, 2002), (b) unrelated to employee well-being (Conti et al., 2006), or (c) experienced as a result of improved employee well-being.

Third, as this study is specific to the pharmaceutical industry, it is advised that future research should further validate the above results for additional types of chemical manufacturing which share similarities in process complexity (e.g. requirement of regular and timely product changeover while preventing cross-contamination), and alternative industries which have lower levels of process complexity. The complexity of the production process is relevant to the examination of its work environment as previous findings which demonstrate negative effects of lean manufacturing were specific to roles which were manual in nature and had low levels of complexity (Hasle et al., 2012). Findings of previous studies further suggest that working conditions under more complex job roles for qualified employees were, in fact, improved as a result of lean manufacturing (Parker, 2003; Schouteten & Benders, 2004). However, Seppällä and Klemola (2004) found that the work of white collar groups was impacted to a greater extent by lean manufacturing than that of blue collar groups in terms of increased pressure and responsibility. In order to clarify this issue, future research should consider using multi-group analysis to examine the relationships presented in this thesis across different job roles within an organisation (e.g. production operatives, support staff, supervisors etc.), and across a variety of occupational groups and industries.

Finally, job design under lean manufacturing was examined in this thesis as an individual level phenomenon whereby all job characteristics were measured using the individual as its referent. Similarly, job crafting activities were assessed in relation to the individual's likelihood to engage in crafting behaviour by themselves. However, due to the interdependent nature of work in this context, a number of job characteristics and redesign activities may also be prominent at the collective level. For example, some authors have proposed that lean manufacturing inhibits individual control over task execution yet enhances collective control over task design and work methods (Klein, 1991). In relation to this, Jackson and Mullarkey (2000) found that collective method control had a significant relationship with employee well-being, while individual method control was unrelated to it. Therefore future research should examine the impact of the lean-specific characteristics identified in this thesis (e.g. control, performance feedback and problem solving) at the group level of analysis. Furthermore, as the job crafting actions carried out by an individual within an interdependent team can impact the task and social environment for others in that team, recent studies have established that job crafting is also a team-level phenomenon whereby job redesign activities are carried out collectively within the team (Leana et al., 2009; Tims et al., in press). Study 3 demonstrated how team characteristics (i.e. task interdependence) inhibit the facilitation of individual crafting as employees are reluctant to use their resources to make individual changes to their work as it will also impact the work of colleagues dependent on them. However, Leana and colleagues (2009) found that task interdependency was positively related to collaborative job crafting, where employees determine together how they can alter their work in order to meet their shared work goals. Therefore, future research, particularly research which addresses interdependent contexts such as lean manufacturing, should consider how employees combine their efforts to increase resources and challenges and reduce demands as a team process.

5.4 Practical Implications

On reviewing the literature surrounding the impact of lean manufacturing on employee outcomes, Hasle (2012) concluded that a picture in which positive and negative effects thrive side by side has emerged. With this in mind, the question now faced is how to simultaneously minimise adverse effects while enhancing the positive effects. The results of this research offer a number of recommendations as to how this balance can be achieved by lean practitioners. First, the proposed relationships in Study 1 which were supported by the results of Study 2 demonstrate the crucial role of lean resources for promoting engagement and reducing exhaustion. Therefore, managers' provision of specific job resources to employees working within this context is essential for maintaining a healthy work environment. For example, as lean manufacturing requires the application of both technical and 'soft' team-working skills (Sterling & Boxall, 2013), training in both skill sets are an essential aspect of its success (Moyano-Fuentes & Sacristan-Diaz, 2012). Training can be delivered through formal programmes in the areas of quality, customer service and people management, or through more informal on-the-job activities such as job rotation and the creation of work groups responsible for quality improvement, product development and task flexibility (Adler, 1990; de Treville & Antonakis, 2006; Kabst et al., 1996). Boundary control should also be provided to employees working under lean manufacturing by delegating activities typically carried out by the supervisor to the shop floor. This would allow employees to carry out their own quality inspection, machine maintenance and peer-training. The selection of boundary control as a lean resource in Studies 1 and 2 as opposed to general autonomy (Hackman & Oldham, 1976) is due to the fact that lean manufacturing is designed to increase employee responsibility and decision latitude yet inhibit employee choice over procedure and timing (de Treville & Antonakis, 2006; Jackson & Mullarkey, 2000; Sprigg & Jackson, 2006). Therefore, it is important for managers to understand and differentiate between the type of employee control encouraged by this design (i.e. boundary control), and the type of employee control restricted by this design (i.e. method and timing control). Finally, performance feedback is a necessary job resource to ensure timely feedback and performance tracking under lean manufacturing (Forza, 1996; Greller & Herold, 1975). Although feedback is commonly guaranteed under lean manufacturing through statistical process controls and visual displays, it is important for managers to provide supplementary feedback which is used constructively and at the group aggregate level to avoid the development of a 'blame' culture (Conti et al., 2006).

Second, support for the interaction hypotheses proposed in Study 1, and found in Study 2, indicates that the demands associated with lean manufacturing should not be considered as unanimously harmful characteristics for employees. Rather, managers should focus their efforts on the provision of resources as outlined above, which complement the increased demands experienced by employees in this interdependent, fast-paced context where pressure to monitor processes and solve production problems are heightened. In fact, the findings of Study 2 demonstrate that although these demands are harmful in isolation, they are responsible for activating the motivational potential of job resources in promoting work engagement. For example, if employees are not required to make decisions and deal with issues arising in the production process, many of the skills acquired throughout their training will remain unused and become redundant. In the same breath, the psychological and physical costs associated with problem solving and decision making are minimised when employees have adequate skills to cope with these demands. Therefore, managers should ensure that employees are challenged enough to utilise their resources without allowing demands to become excessive and regain their potential for health-impairment.

Finally, the findings of Study 3 demonstrate the beneficial role of job crafting in promoting employee engagement. In other words, employees who were able to initiate the expansion of their resources and challenges on a regular basis (e.g. learning new things, asking for additional tasks, seeking feedback) were more likely to experience high levels of engagement. Of particular interest to managers, are the findings which demonstrate that these beneficial job crafting activities can be facilitated by certain aspects of their job design. Specifically, managers should ensure that employees have the opportunity to utilise their skills and get involved in problem solving, thereby providing cues which encourage them to further expand the scope of their job role. The results of Study 3 further demonstrate that high levels of task interdependency mitigate the positive effects of these contextual facilitators of job crafting. Therefore managers of interdependent teams (such as those under lean manufacturing) should ensure that levels of interdependence between team members do not become excessive, and aim to maintain adequate levels of autonomy and flexibility for employees to enhance their individual job role and facilitate their personal engagement. As these results are evident at the daily within-person level, they further demonstrate to managers how the decisions they make regarding job design on a short term basis have strong repercussions for how employees react to their work and the quality of their working day. Therefore decisions made by managers to promote specific job resources and challenges should be reinforced and revisited on a regular basis.

5.5 Conclusion

This research is the first examination of the quality of working life under lean manufacturing using a framework which captures both its motivational and health-impairment potential for employees; the JD-R model. Once adapted to reflect the specific characteristics of the lean manufacturing context, this model was tested using a sample of 200 employees working within a multi-national pharmaceutical manufacturing organisation with extensive use of lean practices. Furthermore, the daily experience of this unique work environment was examined using a daily diary study amongst 64 employees within the same organisation. The results of SEM demonstrate the direct and interactive effects of lean-specific resources and demands in predicting motivational and health-impairment outcomes for employees. In doing so, they highlight the need for organisations to consider how lean-specific demands can be supported by the availability of complementary lean-specific resources which in turn provide motivational challenges for employees. Results from multi-level SEM also establish the beneficial role of job crafting in promoting employee engagement in this context, and highlight the daily contextual facilitators of job crafting under lean manufacturing. Overall, the findings of this research demonstrate that the design of jobs impacts both employees' reaction to their work and the quality of their working life. These results apply not only on a general level, but also on a daily basis. The support found for the proposed model provides guidance to practitioners using lean manufacturing, and additionally invites a body of research to investigate how jobs can be enriched within organisations using this manufacturing system.

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Appendix A: Ethical Approval for Research

Dublin City University
Ollscoil Chathair Bhaile Átha Cliath

DCU

Dr. Janine Bosak
DCU Business School

6th May 2011

REC Reference:	DCUREC/2011/037
Proposal Title:	**Exploring the antecedents and outcomes of employee well-being under lean manufacturing**
Applicants:	Dr. Janine Bosak, Ms. Sarah-Jane Cullinane

Dear Janine,

This research proposal qualifies under our Notification Procedure, as a low risk social research project. Therefore, the DCU Research Ethics Committee approves this research proposal. Should substantial modifications to the research protocol be required at a later stage, a further submission should be made to the REC.

Yours sincerely,

pp Fiona Brennan

Dr. Donal O'Mathuna
Chair
DCU Research Ethics Committee

DCU
Office of the Vice-President for Research

Appendix B: Sample Questionnaire for Study 2

SURVEY 2011

THE EMPLOYEE EXPERIENCE *of* LEAN MANUFACTURING

I am currently carrying out a study which addresses the impact of lean manufacturing on employee outcomes as part of my PhD research. I would greatly appreciate your participation in this study. The following questionnaire should only take approx 15 minutes of your time to complete.

I am asking you to kindly complete all questions and to answer them based on your own personal opinion. Of course, confidentiality is completely guaranteed and all completed questionnaires are anonymous. I will be the only person with access to the individual results from the surveys. Participation is voluntary.

Thank you in advance for your participation. If you have any queries regarding the study please do not hesitate to contact me at **sarahjane.cullinane2@mail.dcu.ie**

Yours faithfully,
Sarah-Jane Cullinane

SECTION 1 YOUR WORK RELATED WELL-BEING

The following statements are about how you feel at work. Please read each statement carefully and decide if you ever feel this way about your job (Please tick ***one box only*** for each of the following items)

1 Never
2 Almost Never/A few times a year or less
3 Rarely/Once a month or less
4 Sometimes/A few times a month
5 Often/Once a week
6 Very often/A few time a week
7 Always/Everyday

	1	2	3	4	5	6	7
When I get up in the morning I feel like going to work	❑	❑	❑	❑	❑	❑	❑
At my work I feel bursting with energy	❑	❑	❑	❑	❑	❑	❑
At my job, I feel strong and vigorous	❑	❑	❑	❑	❑	❑	❑
I am proud of the work that I do	❑	❑	❑	❑	❑	❑	❑
My job inspires me	❑	❑	❑	❑	❑	❑	❑
I am enthusiastic about my job	❑	❑	❑	❑	❑	❑	❑
I am happy when I am working intensely	❑	❑	❑	❑	❑	❑	❑
I am immersed in my work	❑	❑	❑	❑	❑	❑	❑
I get carried away when I am working	❑	❑	❑	❑	❑	❑	❑

The following statements are about how you feel at work. Please read each statement carefully and decide if you ever feel this way about your job (Please tick ***one box only*** for each of the following items)

1 Strongly Disagree
2 Disagree
3 Neither agree or disagree
4 Agree
5 Strongly Agree

	1	2	3	4	5
When I work, I usually feel energised	❑	❑	❑	❑	❑
Usually I can manage the amount of my work well	❑	❑	❑	❑	❑
After work I usually feel worn out and weary	❑	❑	❑	❑	❑
There are days when I feel tired before I arrive at work	❑	❑	❑	❑	❑
After work, I tend to need more time than in the past in order to relax & feel better	❑	❑	❑	❑	❑
I can tolerate the pressure of my work well	❑	❑	❑	❑	❑
During my work, I often feel emotionally drained	❑	❑	❑	❑	❑
After work I have enough energy for my leisure activities	❑	❑	❑	❑	❑

SECTION 2 YOU AND YOUR JOB

Please answer the following questions regarding the demands associated with your job (Please tick ***one box only*** for each of the following items)

1 Not at all
2 Just a little
3 A Moderate amount
4 Quite a lot
5 A Great Deal

TO WHAT EXTENT......	1	2	3	4	5
Are you required to deal with problems which are difficult to solve?	☐	☐	☐	☐	☐
Do you have to solve problems which have no obvious correct answer?	☐	☐	☐	☐	☐
Do you have to use your knowledge of the production process to help prevent problems arising in your job?	☐	☐	☐	☐	☐
Do the problems you deal with require a thorough knowledge of the production process in your area?	☐	☐	☐	☐	☐
Do you come across problems in your job you have not met before?	☐	☐	☐	☐	☐
Do you find yourself working faster than you would like in order to complete your work?	☐	☐	☐	☐	☐
Are you under constant pressure at work?	☐	☐	☐	☐	☐
Do you find that work piles up faster than you complete it?	☐	☐	☐	☐	☐
Can you carry out your own routine maintenance?	☐	☐	☐	☐	☐
Can you Inspect the quality of your own work?	☐	☐	☐	☐	☐
Can you call out support yourself when there is a machine problem?	☐	☐	☐	☐	☐
Can you fetch your own kits from the store?	☐	☐	☐	☐	☐
Can you help train other people?	☐	☐	☐	☐	☐
Can you set up your own equipment?	☐	☐	☐	☐	☐
Can you control the scheduling of your own work?	☐	☐	☐	☐	☐

Please indicate your level of agreement with the following statement regarding the characteristics of your work group. (Please tick ***one box only*** for each of the following items)

1 Strongly Disagree
2 Disagree
3 Neither agree or disagree
4 Agree
5 Strongly Agree

	1	2	3	4	5
Members of my team have skills and abilities that complement each other	☐	☐	☐	☐	☐
I cannot get tasks done without information & materials from other team members	☐	☐	☐	☐	☐
Other members of my team depend on me for information or materials needed to perform their tasks	☐	☐	☐	☐	☐
My team holds me accountable for all of my decisions	☐	☐	☐	☐	☐
I am held very accountable for my actions at work	☐	☐	☐	☐	☐
I often have to explain why I do certain things at work	☐	☐	☐	☐	☐
If things do not go the way they should I will hear about it from my team	☐	☐	☐	☐	☐
The jobs of many people at work depend on my successes or failures	☐	☐	☐	☐	☐
In the grand scheme of things my efforts at work are very important	☐	☐	☐	☐	☐
My co-workers and superiors closely scrutinise my work	☐	☐	☐	☐	☐

SECTION 2 YOU AND YOUR JOB

Please indicate your level of agreement with the following statement regarding the nature of your job. (Please tick ***one box only*** for each of the following items)

1 Strongly Disagree
2 Disagree
3 Neither agree or disagree
4 Agree
5 Strongly Agree

	1	2	3	4	5
My superiors/co-workers let me know how well I am doing in my job	❑	❑	❑	❑	❑
The job itself provides me with information about my work performance	❑	❑	❑	❑	❑
Just doing the work required by the job provides many chances for me to figure out how well I'm doing	❑	❑	❑	❑	❑
The superiors & co-workers on this job almost never give me any feedback about how well I am doing in my job	❑	❑	❑	❑	❑
My superiors/co-workers often let me know how well they think I am performing in my job	❑	❑	❑	❑	❑
The job itself provides very little clues about whether or not I am performing well	❑	❑	❑	❑	❑
The company provides adequate technical training for my team	❑	❑	❑	❑	❑
The company provides adequate quality and customer service training for my team	❑	❑	❑	❑	❑
The company provides adequate team skills training for my team (e.g. communication, organisation, interpersonal etc)	❑	❑	❑	❑	❑

SECTION 3 BACKGROUND INFORMATION

Please complete the following section which requests some biographical information. Please note that these details are not for the purpose of respondent identification but rather for the purpose of identifying overall demographic trends. No individual results will be seen by anyone but the researcher.

1. Gender: Male ❑ Female ❑

2. Age: ________years

3. Education Level: Secondary ❑ Certificate❑ Bachelor Degree ❑ Masters Degree ❑
Doctoral Degree ❑ Vocational Training ❑ Other ❑ (please specify) ____________

4. Do you work days or shifts? Day Worker ❑ Shift Worker ❑

5. How many years have you worked with Novartis?
Less than a year ❑ 1-3 years ❑ 4-8 years ❑ 9-15 years ❑ 15+ years ❑

6. What best describes your position in the PU? Operating Team Member ❑
Support Team Member ❑ Process Unit Head ❑ Other (please specify) ❑ __________

Appendix C: Sample Questionnaire for Study 3

A DAY ON THE JOB *with* LEAN MANUFACTURING

- **What is this study about?**

Do you ever find that there are certain days when you feel like going to work and you enjoy your work, and other days when you would rather stay out of work or feel exhausted or distant from your work?

This study is part of a PhD project which looks at how people working with lean manufacturing and POO practices experience their job over the working week. It examines how the nature of the job can change from day to day in terms of demands and challenges faced, support provided etc. and if these changes influence the way you feel about your job on a particular day. This study is a follow up to the survey that many of you completed in 2010/2011 at your PB1 day in Rochestown Park Hotel.

- **Why should I take part?**

Your participation will (a) provide evidence which shows what a working week looks like for those using POO and lean practices, and how daily changes in the nature of this work impacts worker health, (b) provide you with the option to get a report of the overall study results, and (c) provide you with the chance to enter a draw for an An Post One for All voucher to the value of €50.

- **How can I participate?**

Participation in the study requires the completion of a once off general survey, and a short survey for 4 consecutive shifts or 5 consecutive days. The general survey takes approximately 10 minutes to complete and should be completed prior to or on the first day of the week/shift. The daily survey takes 5 minutes to complete and should be completed every day close to the end of each shift/day before you finish work (between 16.00 & 17.00 for day work, between 18.00 & 19.00 for shift work). Completed surveys will be collected at the end of each day either by me or an assigned member of your team.

Participation in the study is voluntary and should you wish to participate I ask that you kindly complete all questions and answer them based on your own personal opinion. There are no right or wrong answers so don't spend too much time thinking about your responses. All completed questionnaires are anonymous and I will be the only person with access to the individual results from the surveys.

Thank you in advance for your participation. If you have any queries regarding the study please do not hesitate to contact me at sarah-jane.cullinane@dcu.ie or 0858217301

Yours faithfully,
Sarah-Jane Cullinane,
IRCHSS Government of Ireland Postgraduate Scholar, DCU Business School, Dublin City University.

GENERAL SURVEY — Section 1: Your Well-Being at Work

The following statements are about how you feel at work. Please read each statement and decide if you ever feel this way about your job.

	Never			Sometimes/A few times a month			Always/ Everyday
When I get up in the morning I feel like going to work	1	2	3	4	5	6	7
At my work I feel bursting with energy	1	2	3	4	5	6	7
At my job, I feel strong and vigorous	1	2	3	4	5	6	7
I am proud of the work that I do	1	2	3	4	5	6	7
My job inspires me	1	2	3	4	5	6	7
I am enthusiastic about my job	1	2	3	4	5	6	7

Section 2: You and Your Team

Please indicate your level of agreement with the following statements.	Strongly Disagree			Unsure			Strongly Agree
Members of my team have skills and abilities that complement each other	1	2	3	4	5	6	7
I cannot get tasks done without information & materials from other team members	1	2	3	4	5	6	7
Other members of my team depend on me for information or materials needed to perform their tasks	1	2	3	4	5	6	7

Section 3: Background Information

Please complete the following section which requests some biographical information. Please note that these details are not for the purpose of respondent identification but rather for the purpose of identifying overall demographic trends. No individual results will be seen by anyone but the researcher.

What is your gender? Male ❑ Female ❑

What is your age? 16-24 ❑ 25-44 ❑ 45-64 ❑ 65+ ❑

How long have you worked for _____? Less than a year ❑ 1-3 years ❑ 4-8 years ❑ 9-15 years ❑ 15 years+ ❑

Do you work days or shifts? Day worker ❑ Shift worker ❑

What best describes your position in the PU? Operating Team Member ❑ Support Team Member ❑ QA Support ❑

Current employment status? Permanent Full-Time ❑ Permanent Part-Time ❑ Temporary Full-Time ❑ Temporary Part-Time ❑

What are the last 5 digits of your mobile phone number? (This is for the purpose of matching each of your surveys to one another, not for identification of the respondent) ___________

DAILY SURVEY

Date: ___/____/___ Time: __:__

Did you work a day or night shift? Day ❑ Night ❑

What are the last 5 digits of your mobile phone number? (This is for the purpose of matching each of your surveys to one another, not for identification of the respondent) ____________

Section 1

Please carefully read each statement about your work today and indicate your level of agreement.

Today.....	Strongly Disagree 1	2	3	Unsure 4	5	6	Strongly Agree 7
....my co-workers/coordinator let me know how well I was doing in my job	1	2	3	4	5	6	7
....the job itself provided me with information about my work performance	1	2	3	4	5	6	7
....just doing the work required by the job provided me with chances to figure out how well I was doing	1	2	3	4	5	6	7
....I could vary how I did my work	1	2	3	4	5	6	7
....I could decide how to go about getting my job done	1	2	3	4	5	6	7
....I could choose the methods to use in carrying out my work	1	2	3	4	5	6	7
....I found myself working faster than I would like in order to complete my work	1	2	3	4	5	6	7
....I found that work piled up faster than I could complete it	1	2	3	4	5	6	7
....I was under constant pressure at work	1	2	3	4	5	6	7
....I was required to deal with problems which were difficult to solve	1	2	3	4	5	6	7
....I needed to use my knowledge of the production process to solve problems arising in my job	1	2	3	4	5	6	7
....I came across problems that I had not met before	1	2	3	4	5	6	7
....when I got up, I felt like going to work	1	2	3	4	5	6	7
....I felt bursting with energy during work	1	2	3	4	5	6	7
....I was proud of the work that I did	1	2	3	4	5	6	7
....I was enthusiastic about my job	1	2	3	4	5	6	7
....I will need more time than usual in order to relax and feel better after work	1	2	3	4	5	6	7
....I felt emotionally drained during work	1	2	3	4	5	6	7
....I could tolerate the pressure of my work well	1	2	3	4	5	6	7

Section 2

Please carefully read each statement about your work today and indicate your level of agreement.

Today.....	Strongly Disagree			Unsure			Strongly Agree
....I was held accountable for all my actions at work	1	2	3	4	5	6	7
....my team held me accountable for all of my decisions	1	2	3	4	5	6	7
....my work was closely scrutinized by others	1	2	3	4	5	6	7
....I tried to simplify the complexity of my tasks at work	1	2	3	4	5	6	7
....I tried to ensure that my work was mentally less intense	1	2	3	4	5	6	7
....I tried to ensure that my work was physically less intense	1	2	3	4	5	6	7
....I tried to learn new things at work	1	2	3	4	5	6	7
....I asked colleagues for advice	1	2	3	4	5	6	7
....I asked others for feedback on my job performance	1	2	3	4	5	6	7
....I asked for more odd jobs	1	2	3	4	5	6	7
....I asked for more tasks if I finished my work	1	2	3	4	5	6	7
....I asked for more responsibilities	1	2	3	4	5	6	7
....the success of the group rested on my shoulders	1	2	3	4	5	6	7
....I could not get tasks done without information and materials from other team members	1	2	3	4	5	6	7
....other team members depended on me for information or materials needed to perform their tasks	1	2	3	4	5	6	7
....I made full use of my skills	1	2	3	4	5	6	7
....I was challenged by my job	1	2	3	4	5	6	7
....I used a variety of skills	1	2	3	4	5	6	7

Thank you for taking the time to complete today's daily survey. Your efforts are greatly appreciated.
Should you wish to discuss any aspect of the study further please do not hesitate to contact me on 085-8217301 or email me at sarah-jane.cullinane@dcu.ie

Please feel free to leave any additional comments here.

Appendix D: Lean Assessment Questionnaire

Level of Lean Implementation (IQP & POO)				
Please indicate the extent of the implementation of each of the following practices in your plant. Write the number in the space provided, using the following rating scale. Source: Shah & Ward, 2007				
No Implementation	Little Implementation	Some Implementation	Extensive Implementation	Complete Implementation
1	2	3	4	5

	Section 1: Supplier Feedback	Score
1	We are frequently in close contact with our suppliers	
2	Our suppliers seldom visit our plant	
3	We seldom visit our suppliers plant	
4	We give our suppliers feedback on quality and delivery performance	
5	We strive to establish long term relationships with our suppliers	
	Section 2: Just-in-Time Delivery by Suppliers	
6	Suppliers are directly involved in the new product development process	
7	Our Key suppliers deliver to the plant on a Just-in-Time basis	
8	We have a formal supplier certification program	
	Section 3: Supplier Development	
9	Our suppliers are contractually committed to annual cost reductions	
10	Our suppliers are located in close proximity to our plants	
11	We have corporate level communication on important issues with key suppliers	
12	We take active steps to reduce the number of suppliers in each category	
13	Our key suppliers manage our inventory	
14	We evaluate suppliers on the basis of total cost and not per unit price	
	Section 4: Customer Involvement	
15	We are frequently in close contact with our customers	
16	Our customers seldom visit our plants	
17	Our customers give us feedback on quality and delivery performance	
18	Our customers are actively involved in current and future product offering	
19	Our customers are directly involved in current and future product offerings	
20	Our customers frequently share current and future demand information with marketing department	
21	We regularly conduct customer satisfaction surveys	
	Section 5: Pull	
22	Production here is "pulled" by the shipment of finished goods	
23	Production at stations is "pulled" by the current demand of the next station	

24	We use a "pull" production system	
25	We use Kanban squares, or containers of signals for production control	
	Section 6: Continuous Flow	
26	Products are classified into groups with similar processing requirements	
27	Products are classified into groups with similar routing requirements	
28	Equipment is grouped to produce a continuous flow of families of products	
29	Families of product determine our factory layout	
30	Pace of production is directly linked with the rate of customer demand	
	Section 7: Set Up Time Reduction	
31	Our employees practice setups to reduce the time required	
32	We are working to lower setup times in our plants	
33	We have low set up times of equipment in our plant	
34	Long Production cycle times prevent responding quickly to customer requests	
35	Long supply lead times prevent responding quickly to customer requests	
	Section 8: Statistical Process Control	
36	A large number of equipment/processes on the shop floor are currently under statistical process control	
37	Extensive use of statistical techniques are used to reduce process variance	
38	Charts showing defect rates are used as tools on the shop-floor	
39	We use fishbone type diagrams to identify causes of quality problems	
40	We conduct process capability studies before product launch	
	Section 9: Employee Involvement	
41	Our shop-floor employees are key to problem solving in teams	
42	Our shop-floor employees drive suggestion programmes	
43	Our shop-floor employees lead product/process improvement efforts	
44	Our shop-floor employees undergo cross functional training	
	Section 10: Total Productive/Preventative Management	
45	We dedicate a portion of everyday to planned equipment maintenance related activities	
46	We maintain all our equipment regularly	
47	We maintain excellent records of all equipment maintenance related activities	
48	We post equipment maintenance records on the shop-floor for active sharing with employees	
	Section 11: Visual Process Management	
49	Extensive use of visual boards on the shop-floor are used to clearly present the progress of our processes	
50	Visual process management is used to complement our performance management system	
51	Shop-floor teams are empowered to develop their own visual process boards	