THE HUMAN COSTS AND BENEFITS OF WORK:
JOBLOAD, SELF-PERCEIVED PERFORMANCE,
AND EMPLOYEE WELLBEING

Submitted by
Peta Miller

La Trobe University

November 2004
THE HUMAN COSTS AND BENEFITS OF WORK:
JOBLOAD, SELF-PERCEIVED PERFORMANCE,
AND EMPLOYEE WELLBEING

Submitted by
Peta Miller
Bachelor Applied Science (Occupational Therapy)
Graduate Diploma in Ergonomics

A thesis submitted in total fulfillment of the requirements for the degree of Doctor of Philosophy

School of Human Biosciences
Faculty of Health Sciences
La Trobe University
Victoria 3086
Australia

November 2004
ACKNOWLEDGMENTS

I would like to gratefully acknowledge the help and guidance of my supervisor Associate Professor Wendy Macdonald in the completion of this thesis. I would also like to thank Dr John Schuijers for his help with preparation of chemicals and with the assaying of urine samples, Associate Professor Owen Evans for his advice on calculation routines for urine samples, and Associate Professor Errol Hoffmann for his assistance in proof reading of the final thesis. I am also very grateful for the financial assistance provided by the Australian Postgraduate Scholarship Scheme, which greatly enhanced my ability to undertake this research.

I would also like to sincerely thank all of the participants in this research, and their managers, for making this research possible; my colleagues for their patience and support; my husband Jonathon Miller, and my mother Dorothy Giles for their unfailing emotional support. Lastly I would like to thank my daughter Hilary for providing many cups of tea.

This thesis is dedicated to my wonderful mother, Dorothy Giles, and to the memory of my late father, Dr Ron Giles.
STATEMENT OF AUTHORSHIP

Except where reference is made in the text of the thesis, this thesis contains no material published elsewhere or extracted in whole or in part from a thesis submitted for the award of any other degree or diploma. No other person’s work has been used without due acknowledgement in the main text of the thesis. The thesis has not been submitted for the award of any degree or diploma in any other tertiary institution.

The author acknowledges that assaying of urine samples for urinary free cortisol was undertaken by the Austin Rehabilitation Pathology Department.

The research procedures reported in this thesis were approved by the LTU Human Ethics Committee, Reference Number 99/19

Peta Miller
Student Number: 95262151

18 November 2004
The primary purpose of this project was to investigate some relationships between workload and employee wellbeing. The necessary first stage was to formulate a theoretical framework – the JobLoad Model – to support a comprehensive and detailed investigation of the main factors that contribute to a job's workload. Building on the ergonomics concept of ‘workload’, this Model incorporates task- and job-level factors that have been identified within the research literatures of physical and cognitive ergonomics as important; additional constructs were added to take account of additional factors shown to be relevant to employee wellbeing, drawing on evidence from occupational health and organizational psychology literatures. Using this framework, available questionnaire-based measurement instruments for assessing workload and employee wellbeing were reviewed, new items were developed as required, and the JobLoad Index (JLI) was developed.

The JLI was used to collect data from public servants in two different workplaces, with participation rates of 63% and 73% respectively. Relationships were determined between major task, job and organisational environment factors, self-perceived performance adequacy, and various aspects of employee wellbeing including job satisfaction, physical discomfort and psychological fatigue, stress and arousal. For a sub-sample of participants in one of the two workplaces, levels of adrenaline, noradrenaline and cortisol were also measured from 24-hour urine collections.

The factors measured by the JLI accounted for a very substantial proportion of variance in these various dimensions of work-related wellbeing. The results provide potentially very useful insights into the relative influences of a wide range of work- and job-related variables on people's perceived abilities to cope with their job demands, and on several aspects of their wellbeing. Further, the importance of measuring multiple dimensions of wellbeing, and differentiating their separate sets of work-related determinants, was well demonstrated. Finally, and perhaps most significantly, this study has identified the powerful role that self-perceived performance plays as an intervening variable between job demands and people's work-related wellbeing.
TABLE OF CONTENTS

Chapter 1. INTRODUCTION AND STUDY AIMS

INTRODUCTION ........................................................................................................................ 1
STUDY AIMS .............................................................................................................................. 4

PART 1: THEORETICAL FOUNDATIONS

Chapter 2. WORKLOAD

THE ERGONOMICS CONCEPT OF ‘WORKLOAD’ ............................................................... 7
WORK DEMANDS ................................................................................................................... 12
COPING CAPACITY ................................................................................................................ 24
JOB CONTROL AND VARIETY ............................................................................................. 29
SUMMARY ............................................................................................................................... 33

Chapter 3 WELLBEING AND PERFORMANCE

THE NATURE OF WELLBEING ............................................................................................. 35
AROUSAL ................................................................................................................................. 41
FATIGUE ................................................................................................................................... 45
PHYSICAL DISCOMFORT ...................................................................................................... 46
WORNOUT ................................................................................................................................ 51
STRESS ...................................................................................................................................... 51
JOB SATISFACTION ............................................................................................................... 58
SELF-PERCEIVED PERFORMANCE CAPACITIES AND ADEQUACY ....................... 60
SUMMARY ............................................................................................................................... 64

PART 2: DEVELOPMENT OF MEASUREMENT INSTRUMENT

Chapter 4. MEASUREMENT REQUIREMENTS AND AVAILABLE MEASURES

INTRODUCTION ...................................................................................................................... 66
TASK AND JOB DEMANDS MEASURES FROM STRESS/HEALTH PSYCHOLOGY .... 71
MEASURES OF JOB PERFORMANCE .................................................................................. 75
MEASURES OF WELLBEING ................................................................................................ 76
CONSTRUCTS TO BE INCLUDED IN THE JOBLOAD INDEX .......................................... 78

Chapter 5. STUDY DESIGN & DATA COLLECTION PROCEDURES

SELECTION OF STUDY SITES & APPROVAL PROCESS .................................................. 81
PHASES OF THE STUDY ........................................................................................................ 83
JOB DESCRIPTION .................................................................................................................. 84
GENERAL METHODOLOGICAL PROBLEMS ..................................................................... 89

Chapter 6. DATA PREPARATION AND DEVELOPMENT OF THE JOBLOAD INDEX
Chapter 1

INTRODUCTION AND STUDY AIMS

INTRODUCTION

In Australia, the majority of adults continue to work, for financial reward, for a large portion of their adult lives. However, the nature of their work, and where, when, and especially how hard people work, has changed a great deal over recent decades. Since labour costs constitute a major expenditure for most Australian employers, many are interested in finding ways to minimise staffing levels (Heiler, Pickersgill & Briggs, 2000) whilst trying to maximise or at least maintain their productivity. Motivated by the desire to improve performance and competitive advantage, many Australian organisations have implemented organisational restructuring, downsizing, new workplace enterprise agreements, technologies and methods of work, all which have had profound impacts on employee workloads (O’Donnell, 1997; Wright & Lund, 1996).

In the face of these pressures, despite the fact that there are more part-time and casual workers than ever before, the average length of the working week has significantly increased and 45.7% of Australians now work more than 40 hours per week (ABS, 2003). Further, of those working longer than 49 hours per week, most are doing so because of formal or informal obligations to work until they have finished particular tasks (Heiler, 2001; Queensland Government, 2001). Workplace changes are not just affecting the hours that people work but also the intensity of work, as people are required to work harder, faster and on more complex activities (Green, 2002; O’Donnell, 1997).

Although these changes are usually driven by a desire to improve productivity, they have not always achieved the intended gains (Bennett, 1991; Gandolfi & Neck, 2003). Further, West (2000) concluded from a meta-analysis of the effects of downsizing on survivors that there were also unintended and negative effects on employee wellbeing and on their organisational commitment. There is growing awareness both in Australia and internationally\(^1\) that these workplace changes have implications both for organisational productivity and for employee wellbeing both at work and at home. This is reflected, for example, in submissions to the recent test case on “Reasonable Working Hours” before the Australian Industrial Relations Commission

\(^1\) e.g. European Parliament’s Directive 2000/34/EC on Working Time and UK Health and Safety Executive’s Draft Management Standards for Stress.
Governments, employers and employee representatives all acknowledge their legal responsibility to ensure safe workplaces and systems of work, but the means by which these responsibilities can and should be translated into effective occupational health and safety (OHS) programs are still being fiercely debated. While a coordinated, national approach to these problems has not yet emerged in Australia, many of the State and Territory Governments have already begun to develop and implement regulations and associated standards, codes of practice and guidance material to address the increased risks for musculoskeletal disorders, stress and fatigue resulting from workplace change and restructuring. However, these efforts have taken little if any account of the central importance of workload as conceptualised by ergonomists.

To help to address this deficiency, a primary purpose of the present project is to develop a conceptual framework that will be able to support more effective identification and assessment of OHS risks related to inappropriate workloads, taking a broader, ergonomics-oriented view. Currently, ‘workload’ within the domains of occupational health, occupational health psychology and organisational psychology is considered very simplistically – commonly as a unidimensional variable. Ergonomists have developed a much more sophisticated view of the workload associated with performance of specific tasks. However, it is argued in this thesis that the ergonomics concept of workload, and related measurement methods, are too focused on the performance of specific tasks, and too little concerned with worker wellbeing, to support effective management of the workload experienced by job incumbents in the ‘real world’. This project is intended to provide a bridge between these different domains of professional research and practice, with a focus on workload; ergonomics literature related to workload is critically analysed and reviewed.

There is also a very large literature on the nature and determinants of occupational stress, which is usually acknowledged as one important component of employee wellbeing. It is beyond the scope of this thesis to critically analyse and evaluate this literature, in addition to that on workload, but key concepts and relevant findings are summarised. The empirical evidence is clear that work can have both benefits as well as ‘costs’ (such as stress) for employee wellbeing; being employed in well-designed jobs with manageable workloads can be highly beneficial, providing people with financial security, and opportunities for physical and mental activity,  

2 For example, Code of Practice: Workplace Violence; Workplace Stresses; Health and Safety Guidelines for Shift Work and Extended Working Hours; Fatigue management guidelines for the Forestry industry; Work Environment - Driver Fatigue; Guidance on designing schedules and rosters to minimise fatigue;
personal growth, self-validation, socialisation, and a sense of belongingness. In contrast, poorly designed work with excessively high or low workload can have potential ‘wellbeing costs’, ranging from fatigue, discomfort, stress and job dissatisfaction, to seriously debilitating work-related injuries and diseases, or even death (Briner, 2000; Bosma, Peter & Goldstein, 1995; Schnall, Schwartz, Landsbergis, Siegrist & Marmot, 1998; Siegrist, 1996; Stansfeld, Fuhrer, Head, Ferrie & Shipley, 1999; Warren & Pickering, 1998).

A central tenet of this thesis and a focus of study is that for many people, their work performance is linked to their wellbeing. Successful work performance helps to protect job security, and can also be an important source of pleasure and satisfaction. In contrast, when people fear that their performance may be inadequate, resultant stress can significantly erode wellbeing and health (Bosma, Peter, Goldstein, 1995; Schnall et al., 1994; Siegrist & Marmot, 1998; and Goldstein, 1995).

However, identifying and maintaining optimal workload levels is difficult, because relationships between workload, performance and wellbeing are complex, and under-theorised. As Macdonald and Miller (2004) observed we “cannot assume that high workloads are necessarily stressful, nor that people with high workloads are dissatisfied with their jobs. People in such jobs might be dissatisfied, for various possible reasons including high levels of stress and/or excessive workloads. In addition – or alternatively – they might experience feelings of considerable satisfaction, even exhilaration, related to their capacity to perform well in highly demanding jobs.” In order to better understand these undoubtedly complex relationships, further research such as the current study is required, in order to better understand the work-related factors that contribute to a worker’s experience of the workload associated with performance of their overall job, and the linkages with both positive and negative aspects of employee wellbeing.

Under Australian law, there are clear legislative requirements for employers to ensure that they are providing safe and healthy workplaces and systems of work. To improve productivity whilst meeting this obligation, managers must create environments and decide on staffing levels and workloads that at a personal level are tolerable and sustainable, that do not result in illness and injury, and that allow the organisation to achieve performance requirements and maintain viability. Ideally, they would also be interested in creating working environments and conditions that actively promote positive employee wellbeing. To achieve these outcomes, managers need to understand the main workload factors in their workplaces that will affect both performance and employee wellbeing, so that they can then implement appropriate management strategies.
Ergonomists are now able to accurately identify and analyse many of the physical and psychological demands, aspects of workload and consequences of mismatches between task demands and employee capacities (Kirwan & Ainsworth, 1992; Wilson & Corlett, 1995; Salvendy, 1997). However, neither ergonomists nor any other professional group have previously formulated a theoretically coherent view of the nature and determinant of ‘workload’ related to the performance of whole jobs, rather than related to the performance of a specific task.

In contrast to the concept of task-related workload developed by ergonomists, the concept employed by organisational, industrial and occupational health psychologists is akin to the everyday concept whereby ‘workload’ is refers primarily by the amount of work to be completed, although some operational definitions in this domain take some account also of difficulty. The present study therefore represents a major conceptual development, with potential practical application to improve workload management strategies in ways that will enhance both performance and wellbeing.

The concept of workload formulated in this thesis – the JobLoad Model – incorporates important task and job level factors identified within the research literatures of physical and cognitive ergonomics, and health psychology. Empirical data collected in two different work organisations are then used to investigate effects of the nature of the job, and varying levels of major task, job and organisational environment factors on self-perceived performance adequacy, and on various aspects of employee wellbeing, including self-perceived performance, job satisfaction, positive affect as well as stress-related negative affect, fatigue and related somatic states.

STUDY AIMS

In light of the nature of this project, which does not entail formal experimentation, it was deemed more appropriate to specify specific research objectives rather than hypotheses. These objectives were based on an analysis and critical review of research literature in the domains of cognitive and physical ergonomics, focusing on theoretical constructs and related research evidence concerning the nature and determinants of ‘workload’.

Findings from this literature review were supplemented by evidence drawn from the domains of occupational health psychology, organisational psychology and occupational health and safety. The specific objectives were:
1. to formulate a conceptual JobLoad Model, to provide a more detailed and comprehensive account of the main factors which contribute to the workload of a whole job;

2. to develop a questionnaire for use in measuring each of the constructs within the JobLoad Model (collectively termed the Job Load Index – JLI), based on a review of existing questionnaires and the development of new items as necessary;

3. using the JLI, to determine relationships between a range of task, job, and environmental factors as identified by the JobLoad Model, and the following aspects of wellbeing:
   I. ‘Self-perceived performance capacity and adequacy’ (SPPCA)
   II. psychological and physical fatigue (using a ‘Wornout’ scale, and ratings of ‘Bodily Discomfort’)
   III. subjective ‘Stress’, and levels of ‘stress’ hormones (Adrenaline, Noradrenaline and Cortisol)
   IV. subjective ‘Arousal’
   V. ‘job satisfaction’.

~©~
PART 1: THEORETICAL FOUNDATIONS
Chapter 2

WORKLOAD

THE ERGONOMICS CONCEPT OF ‘WORKLOAD’

In this chapter, ergonomics literature on ‘workload’ and its main determinants is critically reviewed and the limitations of current conceptual models discussed. A new framework for understanding the workload of a whole job, rather than just of specific tasks – the Job Load Model – is then developed.

In common usage, ‘workload’ refers simply to the amount of work that must be completed in accord with job requirements. However, more formal notions of workload have been developed within the field of cognitive ergonomics or human factors psychology. Gopher and Donchin (1986), O’Donnell and Eggemeier (1986) and Jex (1988) supported the view of Wickens (1984) that a critical element of mental workload at any point in time is the discrepancy between the individual’s information processing capacity and that required for task performance. Macdonald (2003) observed that while some views of ‘workload’ (e.g. those of Gopher and Donchin, 1986; Jex, 1988) are largely embedded within the original, information processing research framework, others represent workload as a far more inclusive, multidimensional construct, incorporating external factors, internal factors and the resultant costs and gains to both the incumbent and to the system (see for example Kantowitz, 1987; Nachreiner, 1995; Hart & Staveland, 1988; Meijman & O’Hanlon, 1984; Moray, 1982; Xie & Salvendy, 2000).

Hart and Staveland (1988) highlighted the ‘cost of performance’ when they stated that

“workload is a hypothetical construct which represents the cost incurred by a human operator to achieve a particular level of performance”, and that an “operator’s subjective experience of workload summarizes the influences of many factors in addition to the objective demands imposed by the task” (Hart & Staveland, 1988, p.140).

The idea of dynamic interaction between task demands and the individual’s capacity to cope with them is central to all ergonomics concepts of workload. For example, Moray stated that “workload is not a property of the task, but of the interaction between the person and the task” (Moray, 1982, p.128). He also stated that workload cannot be defined simply in terms of the task demands as
these will be experienced differently by different people: an individual’s perception of the demands (or load) is influenced by their level of skill and experience, their attitudes to that task or job and to the circumstances under which work is performed.

Several important elements within this concept of ‘workload’ were specified by Hart and Staveland (1988) when developing the NASA Task Load Index (TLX) to measure the workload associated with performance of a specific task. Based on empirical research, they identified the following dimensions: mental demands, physical demands, temporal demands, effort expended, adequacy of own performance, and frustrations experienced. Similar to this, the Subjective Workload Assessment Technique (SWAT) was developed concurrently with similar applications in mind. It measures the following three dimensions: mental effort, time pressure, and psychological stress (e.g. see Reid & Nygren, 1988; Luximon & Gunnetilleke, 2001).

The above views all represent workload, not as an inherent property of the task or job, but as a multidimensional construct which represents the individual’s subjective experience of the product of the dynamic interaction between work demands, the specific circumstances in which the work must be performed and the individual’s perception of their own coping abilities and performance adequacy. The overall experience of ‘workload’ thus encompasses perceived levels of task demands, effort expended, performance quality and the person’s associated cognitive evaluation and affective state (see Hancock & Desmond, 2001; Hancock & Meshkati, 1988; Helander, 1997, p.958; Huey & Wickens, 1993; Moray, 1979; Singleton et al., 1971). Task demands that may influence workload levels include the actual number of tasks and the “absolute load work-intensity and duration and the work circumstances” (Meijam & O’Halan, 1984), time loads (Reid & Nygen, 1988), and the difficulty or complexity (Yeh & Wickens, 1985) of the tasks that are performed.

Macdonald (2003) noted that most applications of the workload construct within the domain of cognitive ergonomics have been almost entirely confined to the workload associated with the performance of particular tasks rather than of whole jobs. Figure 2.1 however, also refers to the circumstances and environment in which work is performed, which is a step towards encompassing overall work demands in addition to the demands of specific tasks. Figure 2.1 also encompasses some aspects of the individual’s resultant state of wellbeing, including fatigue and perceived success in meeting performance requirements. This representation of workload provided the basis for development of a more broad-based and detailed formulation of job-related workload, suitable for supporting the present project. This formulation, termed the JobLoad Model, is depicted in broad outline in Figure 2.2.
Central to all ergonomics-based conceptions of workload, whether narrowly focused on a particular task or encompassing a whole job, is the individual’s capacity to cope with demands. The individual’s appraisal of the ‘goodness of fit’ between current demands and their own coping capacity influences both the level of perceived workload (in the cognitive ergonomics sense) and their personal response to it (Cox, 1995; Gopher & Donchin, 1986; French, Caplan & Van Harrison, 1982; Hancock & Meshkati, 1988; Kantowitz, 1987; Moray, 1979, 1982, 1988).

Humans are active agents capable of influencing the fit between work demands and their capacity to cope with these demands, by means of various coping strategies. “Coping may be seen as functional in its attempts to manage demands, by either changing them, redefining them or adapting to them” (Cox, 1995, p.28).

The processes by which people attempt to cope with high work demands are likely to be important determinants of their resultant stress levels.
Hockey, Briner, Tattersall, and Wiethoff (1989), Billings and Moos (1981) and Lazarus and Launier (1978) and others proposed that to manage demanding situations workers may use a wide range of strategies which may include:

- **Cognitive appraisal-focused strategies** – these are indirect attempts to deal with the demand discrepancy by managing the appraisal of the stressful situations such as through situational reframing – approaching high workload periods as a challenge and ‘learning experience’, or reaching the judgement that it is unreasonable to expect that quality performance be sustained in these conditions.

- **Behavioural-coping strategies** – these are overt attempts to deal directly with the demand discrepancy by:
o increasing the effective working time by working more hours or taking fewer breaks;
o increasing effort;
o conserving limited energy
  - by taking regular breaks; or
  - by decreasing the level of effort required: by switching to methods that require less energy, or reducing time spent on tasks by reducing performance quality;
o decreasing the amount of time during which energy expenditure is required, by exhibiting more task irrelevant behaviour such as socialising or taking more breaks, seeking assistance with the task from others;
o avoiding work altogether by taking ‘sickies’ or leaving the job.

• Emotion-focused coping strategies – used to attenuate and regulate the emotional reaction to the demand discrepancy and associated stress by seeking comfort and support from others, or by using alcohol and other drugs to blunt emotions.

• Cognitive problem-focused strategies – these are direct reactive or proactive attempts to deal with the demand discrepancy by reducing the overall demand. This may be achieved by planning and problem solving such as reordering task priorities, combining tasks, delegating tasks, refusing tasks, deferring the less important tasks, requesting additional resources, learning new skills and techniques, and drawing on own or others past experiences.

People may use all or some of the above coping strategies but they will all have varying costs and benefits. Using cognitive appraisal-focused strategies may preserve the stability of the individual’s psychological state at the expense of performance effectiveness. Using direct behavioural-coping strategies may maintain task performance at the cost of increased effort and physiological activation. Emotion-focused strategies may reduce psychological distress and there may be short-term performance gains if the distress was interfering with performance, but there will be no long-term gains in performance or effort expenditure. With cognitive problem-focused strategies, however, effective performance can be sustained without necessarily increasing effort, provided this is achieved through more efficient planning and organization of the work (Hockey, Briner, Tattersall, & Wiethoff (1989).

Regardless of the strategies adopted, however, it is possible that sometimes demands may exceed coping capacity, for whatever combination of reasons, so that performance suffers. Unless people
are not motivated to exert near-maximum effort, or are not concerned by their inability to cope adequately, their wellbeing is likely to suffer also. Most immediately they might become excessively fatigued, because the process of expending effort to cope with task demands – whether mental, emotional or physical – is inherently fatiguing. If fatigue becomes excessive, a worker’s capacity to cope with demands is likely to be reduced, which may increase the risk of stress as well as of unsatisfactory performance, which increases the risk of consequent negative effects on health.

On the other hand, when work demands stimulate significant effort that results in successful performance, individual wellbeing is likely to be enhanced. Work performance can also have a range of positive outcomes for workers, including greater personal skill and knowledge (enhancing their capacity to cope with this and other similar work), sufficient stimulation to sustain a pleasant or enjoyable level of ‘arousal’, and a high level of job satisfaction both with ‘a job well done’ and more generally.

Relevant concepts and empirical evidence relevant to this framework are reviewed in the following sections.

**WORK DEMANDS**

Work demands are conceptualised here as the set of demands with which people are required to cope in order to fulfil their job requirements. These include the demands of performing each specific work task, demands associated with more general responsibilities, a set of factors here termed ‘work-related contextual demands and impediments’ which are categorised as ‘demands’ because they require effort expenditure to cope with them. This latter category includes having to deal with various kinds of interruptions and impediments to the standard pattern of work performance, and with uncertainties about a range of work-related issues. Finally, there is the overall amount of work that has to be accomplished within particular working hours, which is sometimes referred to as ‘quantitative’ workload (e.g. Karasek, 1985; Spector & Jex, 1998).

**Specific Task Demands**

The NASA Task Load Index (Hart & Staveland, 1988) incorporates scales to measure task-related mental demands, physical demands, temporal demands, and perceived adequacy of own performance, along with ‘effort’ and ‘frustration’. Measurement of the first three of these types of demand is reasonably well based in theory, as outlined below. Temporal demand may influence levels of all four of these scales, and in addition has effects that are not specific to the
performance of particular tasks. In the present framework it is included as a type of general demand.

Mental demands

Mental demands are usually assessed within the context of the human information processing system (e.g. Broadbent, 1958; Fitts & Posner, 1967; Kahneman, 1973; Mowbray, 1953; Ogden et al 1979; Welford, 1967; and Wickens & Carswell, 1997). Probably the most widely used system models are variants of the ‘multiple resource’ model developed by Wickens and his colleagues (e.g. see Wickens and Hollands, 2000), and that of Kahneman (1973), in which a unitary pool of ‘attentional resources’ plays a central role.

![Generic ‘Multiple Resource’ model of the human information processing system](figure)

Figure 2.3. Generic ‘Multiple Resource’ model of the human information processing system (Wickens, 1984, p.123; With permission from the author Wickens & Hollands, 2000)

This generic ‘information processing’ model identifies differences between the stages of information processing (perceptual, cognitive, physical response) in the level of attentional resources that may be required for task performance. It supports a division of demands into sensory/perceptual, cognitive and response stages, at each of which there are specific limitations that have implications both for workload, and for work and job design. ‘Multiple resource’ versions of this generic model (particularly those of Wickens and his colleagues) highlight also the effects on performance capacity of varying levels of compatibility between stimulus input and

---

3 figure from Wellbrink, Zyda, & Hiles (2004, p.37)
output modes, and between the forms of information coding used in stimulus presentation, in memory representations, and the forms of possible responses. Based on such theory and the associated large body of empirical research, it is clearly established that there are overall limitations to our attentional capacity and hence to the amount of information per unit time that we can process.

Task characteristics that are particularly relevant in determining mental demands include: working and long-term memory load, required decision-making rate and complexity, the extent to which attentional resources must be subdivided across different activities or task components, levels of work repetitiveness and monotony (which affect Arousal level and hence performance capacity), and perceived consequences of errors and more general task significance (Kantowitz, 1987; Macdonald, 2003; Proctor & Van Zandt, 1994; Proctor & Proctor, 1997; Salvendy, 1997; Wickens et al., 1998; Wickens & Carswell, 1997).

In many ‘real world’ jobs, it is a very common requirement that we have multiple tasks which must be performed either concurrently or within a limited time, which creates a higher demand in terms of the total amount of information to be processed (Wickens & Carswell, 1997). On the other hand, greater task variety has the potential to make work more stimulating, interesting and satisfying (e.g. Hackman & Oldham, 1980; Karasek, 1979; 1989). Motivation is an important issue here, as depicted by the Kahneman (1973) unitary resource model of information processing. In this model the individual’s level of attentional resources, and hence their capacity to cope with task demands, varies according to their level of physiological activation or arousal, which in turns is influenced by the perceived level of task demands. In this model, motivation influences both the evaluation of task demands and the choice of performance strategies.
The importance of motivation was also highlighted by Jex (1988) who depicted the individual’s ‘motivated capacity’ as central to the consideration of workload. The potential effects of motivation on performance and on perceived performance adequacy are particularly important in normal working situations, where it is probably rare for an individual’s maximum capacities to be reached.

Jex (1988) stated that this limit would be approached (in the case of information processing) only under conditions of maximum possible motivation – such as the operation of equipment during an emergency.

Consistent with this, the present conceptual framework includes within the Coping Capacity component of the model the individual’s motivation to exert effort as well as their capacity to do so. The importance of distinguishing capacity limitations from motivational issues was emphasised by Macdonald (2003):

“application of the Human Factors psychology ‘workload’ concept to the measurement of job stressors would serve to delineate more clearly the separate effect of employee...”
capacity-limited and motivation-limited factors on work performance and associated affective states such as stress, thus enabling managers to monitor and manage workload levels more effectively, as part of a proactive approach to stress management” (p.113).

Physical demands

It is intuitively appealing to equate the active performance of dynamic physical work, of the kind that significantly increases cardiovascular activity, with high workload – for example, performing ‘heavy’ work at a high rate. Metabolic demands may also be a relevant factor, particularly for high peaks in local muscle loads, and for work in hot environments. However, more accurate determination of physical task demands requires consideration also of the much more commonly experienced static physical demands associated with sustaining awkward positions and postures in which joints are operating at the extreme of range of motion (twisting, bending, reaching), and with performing highly repetitive movements (for example when word processing). Both the intensity of such task demands, and the overall duration of task performance, must be considered when evaluating them in relation to coping capacity and possible associated risks to wellbeing (Ashton-Miller, 1998; Devereux et al., 2002; Keyserling, 2000; Kumar, 2001; Macdonald, 2003; Rempel et al., 1998; Rohmert, 1987).

Temporal demands

As noted above, ‘temporal demand’ is one of the key workload dimensions identified by the developers of the NASA Task Load Index (Hart & Staveland, 1988). In that task-specific context, the key characteristic of temporal demand is the rate at which people are required by the task to process information. Researchers have established two highly reliable, quantitative relationships: (1) between the amount of information being processed and choice time (The Hick-Hyman Law), and (2) between varying levels of required response precision and movement time (Fitts’ Law). Level of physical task demand (more specifically, mass of a load being moved) modifies the basic form of Fitts’ Law, such that a movement takes longer when the transported load is larger, for the same level of required precision (see Proctor & Van Zandt, 1994). The performance of even quite simple tasks usually requires some processing of information, and hence some level of mental demand. Since performance time increases with amount of information being processed, increased temporal demand will be experienced if performance has time constraints that allow less than ample time for such processing (Alluisi & Morgan, 1982; Landy et al., 1991; Lehto, 1997).

An increased level of physical demand can also increase temporal demand. First, it may have a direct effect when some degree of precision is required in the movement, as noted above (Proctor
& Van Zandt, 1994). In addition, the process of coping with physical task demands typically results in some degree of local muscle fatigue with a consequent decrease in the maximum force that can be exerted by that muscle group, and hence in the resultant maximum movement velocity (Chaffin & Andersson, 1992; Dugan & Frontera, 2000; Kromer, 1999; Rodgers, 1997). It is plausible then that, when a fatigue-related reduction in muscle capacity results in slower task performance, in a situation when available performance time is limited, there will be a consequent increase in temporal demand.

Increased levels of local muscle fatigue along with more general, whole body and mental fatigue, are also likely to affect people’s ‘willing to spend’ capacity, in Kalsbeek’s (1967) terminology. That is, with a reducing margin between maximum possible effort expenditure and the level of effort demanded for task performance, there is likely to be a reducing willingness to expend effort (whether physical or mental) as the maximum possible level is approached (sometimes termed the ‘workload margin’ or the ‘workload redline’ (Wierwille & Eggemeier, 1993). This phenomenon also would be expected to result in slower task performance, with a consequent increase in temporal demand when the remaining available time threatens to be inadequate.

**Emotional demands**

Macdonald (2003) noted that *emotional demands* have received relatively little attention within human factors psychology literature (Myrtek et al., 1994, being an exception). This is undoubtedly because the focus of research in that domain has been on the evaluation of equipment or products, rather than on job design or employee wellbeing. The emotional demand associated with job performance has been the focus of decades of research, typically in the context of ‘burnout’ among professionals such as health and other human service providers (e.g. Briner, 1999; Bourbonnais et al., 1998; Grandey, 2000; McManus et al., 2002; Totterdell & Holman, 2003).

Much less attention (except in the consideration of more general, interpersonal conflict) has been focused on the affective demands or ‘emotional labour’ associated with the daily communications and interactions required to some extent in almost all jobs. Affective demands will be present in any job that requires *significant interactions with other people* or where *communication* is a *necessary component* of the job, and therefore should be considered in any workload assessment (Macdonald, 2003). These demands have been operationalised in terms of requirements for employees to: mask and hide their true feelings when dealing with situations that would normally be very distressing or threatening; to pretend or try to demonstrate particular feelings; and or to provide emotional support to others when this is requested (Adlemann, 1995; Briner, 1999; Coiera
et al., 2002; Hoschschild, 1983). For example, such demands have been increasing recognised within the growing ‘call centre’ and tele-marketing industry sector, in which staff working under considerable time pressure are required to deal accurately and sensitively with customer enquiries and complaints (e.g. Bagnara, 2000; Briner, 1999; Bultmann et al., 2002; Friedman, 2002; Fornes et al., 1994; Lundberg & Lindfors, 2002). The UK Health and Safety Executive (2001) acknowledged the high emotional (and physical) demands of this kind of work, and have developed advice on working practices that emphasise the need for managements to manage this type of task demand more effectively.

Another type of task-specific affective demand arises from the perception that errors in performance may have potentially serious and unacceptable implications (Moray & King, 1984; Reason, 1990; Sanderson, 1988. Two recent studies have both reported that in punitive organizational climates, staff who perceived that it was risky to admit to errors, or that they were “not allowed to make mistakes” (Mino et al., 1999) experienced greater levels of stress and higher health risks. Mino et al (1999) studied manufacturing workers, and the other study, by Sexton, Thomas and Helmreich (2000), involved aviation and medical workers.

General Job Demands

‘Job demands’ are clearly established as an important factor influencing employee wellbeing, particularly their stress levels. Macdonald (2003) observed that ‘job demand’ is a poorly defined construct, both conceptually and in operational terms. Typically, this broad category includes factors representing any non-physical task demands such as mental or emotional demands that are categorised here as specific task demands. It also typically includes a wide variety of other job characteristics, many of which are not ‘demands’ as defined within the present framework.

One of the earliest models relevant to this construct was the Person-Environment (P-E) Fit model (Caplan et al., 1975; Van Harrison, 1978; French, Caplan and Van Harrison, 1982; Baker, 1985; Schnall et al., 1994), but this did not clearly differentiate ‘demands’ from other types of potential stressors. Following this early model there has been a large amount of research and associated development of conceptual models, of which the most widely cited is the Demand-Control (-Support) Model (e.g. Baker, Israel & Schuman, 1996; de Lange et al., 2003; Dollard & Winefield 1998; Hammer et al., 2004; Head, Stansfeld & Siegrist, 2004; Kivimaki et al., 2002; Kuper & Marmot, 2003). The associated Job Content Questionnaire (JCQ) has been expanded so that the most recent version includes more detail about such demands than previously, but this is not supported by any clear conceptual framework clarifying the nature of ‘demand’. It combines
within the broad category of ‘psychological job demands’ items related to ‘work hard’, ‘no excessive work’, ‘enough time’, ‘conflicting demands’, ‘intense concentration’, ‘tasks interrupted’, ‘hectic job’, ‘wait on others’. Within the separate category of ‘physical job demands’ are items related to ‘much physical effort’, ‘lift heavy loads’, ‘rapid physical activity’, ‘awkward body posture’ and ‘awkward arm positions’. Macdonald (2003) noted that some of these items reflect some aspects of the specific task demand factors identified above, while other items reflect a more holistic experience of the job overall.

Other scales that are commonly used to measure occupational stressors typically include at least one construct representing job demands, although terminology and content vary considerably. Construct labels include ‘workload’ (referring to the amount and difficulty of work; Williams and Cooper, 1998); ‘work pressure’ (Carayon & Zijlstra, 1999); ‘job pressure’ (Vagg & Spielberger, 1998); ‘cognitive demands’, ‘quantitative job demands’ (Hurrell & McLaney, 1988); ‘psychological demands and mental workload’, ‘physical demands’ (Karasek et al., 1998). Cox and co-workers (e.g. Cox & Griffith, 1995, 1996; Cox, Griffiths & Rial-González, 2002) include various types of job demand within their standard set of ‘psychosocial hazards of work’ including work overload or underload, time pressures, high work pace, short work cycle times and uncertainty.

A common theme in this literature is the sense of having ‘too much to do in too little time’, whether the tasks are largely cognitive or physical in nature. Links between excessively high levels of job demand and personal states such as stress, anxiety and depression, as well as poor job performance, have been well documented (Narayanan, Menon, & Spector, 1999; Kalimo, Lindström & Smith, 1997; Landy, 1992; and others). On the other hand, ‘quantitative underload’ can also be a problem. This term refers to situations where there is ‘too little to do’ or work tasks that are highly repetitive or monotonous, where little use is made of a person’s higher level skills and abilities. As noted above in relation to specific task demands, underload in this sense can result in decreased physiological arousal with associated attentional impairment and concomitant risk to performance quality and safety (French, Caplan & Harrison, 1982; Hart & Staveland, 1988; Hurrell & McLaney, 1988; Kalimo, Lindström & Smith, 1997; Rissler, 1979; Young & Stanton, 2002).

The effects of time pressures on the mental and physical demands of specific tasks were discussed above. More generally, time pressures are one of the clearly identified potential stressors, and are represented by items in stressor measurement scales related to ‘time urgency’ (the need to complete the task as quickly as possible) or ‘deadlines’ (the need to complete the task by a predetermined
time) (see for example Alluisi & Morgan, 1982; Hart & Staveland, 1988; Reid & Nygren, 1988; Landy et al., 1991). However, urgent tasks may also be perceived as inherently important and significant, and therefore as desirable and satisfying. This view is supported by Dewe (1991) who observes that workers with ‘Type A’ behaviour patterns often gravitate towards jobs with high time urgency. These individuals, may experience such work as positively stimulating and challenging rather than negatively stressful, provided that task demands are within their capacity and regulatory control (Dewe, 1991). An apparently similar phenomenon was reported by Macdonald (2003) for production line workers performing highly repetitive work; those who reported that they sometimes had to work faster to meet deadlines had lower stress scores and higher levels of job satisfaction.

Similarly, it has been found that an individual’s perceived responsibilities, such as for expensive equipment and materials, can act as stressors, particularly when they affect the safety and wellbeing of others (French and Caplan, 1970; Cox et al., 1993; Maslach, 1993; and others). On the other hand, responsibility is widely acknowledged also as potentially rewarding, endowing those who hold it with increased status and prestige, and greater opportunities for job enrichment and learning (Driscoll et al., 1998; Kalimo et al., 1997).

The temporal schedule of work tasks (work-rest cycles and durations) and of the work shift (shift length, compressed or divided, extent of overtime) can significantly affect health, safety, and work performance (e.g. Grandjean, 1988; Harma et al., 1998; Knutsson & Boggild, 2000; Neri et al., 1995). There is clear evidence that certain work schedules and shift systems disrupt circadian rhythms and sleep, eating, exercise and socialization patterns (e.g. see reviews by Waterhouse, Folkard, & Minors, 1992; Knutsson & Boggild, 2000). During night shifts, arousal levels typically decline to a minimum before dawn, when psychomotor and cognitive capacities will be at their poorest, which means that additional effort will be required to sustain performance during those times. However, Cooper et al (2001) noted that while there are individual differences in tolerances to shift work (1/4 of people never adjust to night shift), some might see night shifts as desirable, on balance, for example as a means of resolving conflict between job and home responsibilities.

Conflicts with a supervisor, with a client, or between coworkers can add substantially to the effort required to complete work tasks, by impeding the effective flow of information and by requiring the expenditure of both emotional and intellectual resources on non-productive activity. Conflicts can range in intensity from the most minor but irritating disagreements to occasionally life-threatening violence. Within a work group, several factors can increase the probability of interpersonal conflict, including: competition amongst co-workers for scarce organizational
resources; perceived lack of organizational justice (e.g. related to the procedures used in management decision making); imbalance in individual operating styles (more competitors than co-operators); and abrasive or dysfunctional personalities (Dewe & O’Driscoll, 2001; Elovainio, Kivimäki & Vahtera, 2002; Jex, 1998). More seriously, workplace violence is a growing concern, having been linked to emotional exhaustion, high levels of stress, disengagement from the workplace and high turnover rates (Maslach, 1998).

**Work-related Contextual Demands and Impediments**

The amount of effort demanded to perform a job can be significantly increased by the need to cope with factors which impede or disrupt performance, or increase uncertainty concerning performance requirements. One of the most commonly reported of such impediments is that of frequent unwanted *interruptions* (Chisholm, Collison, Nelson & Coffey, 2000; Eyrolle & Cellier, 2000; O’Connor & Peters, 1984). Interruptions include any event that briefly diverts attention from the task at hand and hence requires additional attentional resources to maintain appropriate attention allocation. These are especially likely to be problematic when there are multiple, concurrent tasks requiring careful prioritising and an overall high level of attention – for example, in emergency departments (Chisholm et al., 2000) or when dispensing medicines (Flynn, 2001). At the other extreme, interruptions to work that is intrinsically monotonous and repetitive, but where the operator has control over performance rate, may be experienced as desirable and might ultimately benefit task performance by increasing physiological arousal levels to a more optimal level.

*Role uncertainty* or *ambiguity* is another type of impediment to effective performance which is categorised here as a type of demand because it is likely to affect the performance strategies adopted and hence the overall level of effort expended. Uncertainty may exist because of inadequate information about task and work objectives (what has to be achieved; how to do it); performance priorities, especially when resources are inadequate; scope and extent of individual versus team responsibilities; the criteria that should be used to evaluate performance; and co-workers’ expectations (Carayon, 1992; Cooper et al., 2001; Sauter et al., 1992; Landy, 1992; Macdonald, 2003; Osipow & Spokane, 1987).

Another source of uncertainty arises from *role conflict* associated with incompatible demands, such as the simultaneous occurrence of two or more sets of job pressures where compliance with one would make it difficult or impossible to comply with the other. Conflicts often arise when there is poor communication about task responsibilities or performance requirements, or when some aspect of role requirements conflicts with an individual’s values or moral beliefs. Role conflict is often
associated with negative emotional states and increased staff turnover (Cooper et al., 2001; Steel & Mento, 1986; Tetrick, 1992; Quick & Quick, 1984).

Demands and impediments that with ‘better management’ could be eliminated or reduced are likely to be experienced as frustrating, while there may be more acceptance of those that are seen as inherent in that kind of work, or which result from pressures external to the organization (Macdonald, 2001; Rhoades & Eisenberger, 2002). O’Connor et al (1982) hypothesized that impediments such as unwanted interruptions, performance uncertainty and role conflict are most detrimental to highly motivated and capable employees, who are likely to expend considerable effort trying achieve their goals and so are more frustrated when they are unable to perform at a level they find personally satisfying.

*Job insecurity* is consistently cited as a powerful stressor, associated with negative physical and psychological health outcomes (Amick et al., 1998; Carayon, 1993; Cooper et al., 2001; Kuhnert et al., 1992; Probst, 2000; Sauter et al., 1992). There is also evidence that perceptions of job insecurity are associated with decreased safety motivation and compliance with safety procedures, which in turn may lead to higher rates of workplace injuries and accidents (Probst & Brubaker, 2001). Further, people who perceive a threat to their employment security are likely to be more dissatisfied, with negative impacts on both individual performance and organisational effectiveness, and employees may psychologically withdraw from the workplace (Probst, 1999); their organizational commitment is likely to be lower (Jamal, 1990; Meyer et al., 1989) and their turnover rates higher (Spector & Jex, 1991). On the other hand, some people whose job security is threatened may over-compensate, increasing their work effort in the belief that this may afford some protection. The anxiety associated with job insecurity will obviously be more serious where the employee’s skills, experience, age and current vacancy rates make finding a satisfactory alternative job very difficult (Baker et al., 1996; Carayon, 1993; Landy, 1992; Reissman et al., 1999).

**Total Working Hours**

Sparks, Copper, Fired, & Shiroms (1997) undertook a meta-analysis of research on working hours in relation to employee wellbeing and organisational effectiveness. They demonstrated a small but statistically significant correlation between hours of work and health symptoms – both physiological and psychological. In addition to the possible impact on employee wellbeing, long working hours may negatively affect system safety. Very high working hours within sectors such as some types of transport, mining and medicine, where errors can have very serious consequences,
are of growing concern both to OH&S professionals and to system managers (Dawson et al., 2001; Sparks, 1997). Such has been the apprehension related to excessive working hours and fatigue as contributing factor to medical errors that the Australian Medical Association has recently developed a National Code of Practice – Hours Of Work, Shiftwork And Rostering For Hospital Doctors. The United States has gone further with a more prescriptive approach in their “Patient and Physician Safety and Protection Act of 2001” which prescribes a maximum 80-hour workweek and 24-hour work-shift limit for doctors.

However, whether long working hours constitute a wellbeing ‘cost’ or ‘benefit’ to particular individuals depends on, amongst other things, how many hours are worked, over what period, with what intensity, for what perceived rewards, and importantly, with what level of individual choice. Few researchers would dispute that working extreme hours for extended periods is likely to detract from wellbeing (e.g. Ganster and Bates, 2003; Jex & Bliese, 1999; Sparks et al., 1997; Spurgeon, Harrington & Cooper, 1997, Lipscomb et al., 2002, NIOSH, 2004; van der Hulst, 2003), but the evidence for negative effects of moderately high working hours is more equivocal. Negative effects of long hours are often associated with stress, and such effects can in some situations be moderated by high levels of job control and support from others (Bültmann, 2002; Cohen & Wills, 1985. Daniels & Guppy, 1995). Further, empirical data shows that people are often prepared to work quite extreme hours and bear a wellbeing cost if they believe that it produces a social good4 (Deary et al., 1996), or where it is appropriately rewarded (de Jong et al., 2000), or when it enhances feelings of self-worth (Pugliesi, 1995). However, even if individuals are willing to bear a high personal cost to their own wellbeing, acceptance of such work regimes may conflict with the employer's legal responsibility to maintain an acceptable standard of occupational health and safety, or with the government regulator’s responsibility to protect community members and to contain the costs entailed in supporting the community health system.

At an individual level, working very long hours is associated with greater conflict between responsibilities at home versus those at work. This conflict is especially problematic for a parent with primary responsibility for child care, and is a growing problem for many people (Barnett et al., 1992; Hammer et al., 2004; Hall, 1992; Kinman & Jones, 2001).

---

4 for example, doctors’ higher clinical workloads have been found to be related to higher feelings of personal achievement, as well as to higher stress levels
COPING CAPACITY

Personal Characteristics

People differ in their capacity to cope with workplace demands. Everyone brings to work their own unique biomechanical, psychomotor, cognitive and personality attributes, and a diverse range of skills, experiences and personal values, goals and motives. All of these help to determine the individual coping ability, performance strategies and resultant performance quantity and quality (Gopher & Donchin, 1986; Hagberg et al., 1995; Rodahl, 1989). Personal variables were not the focus of the present study, but where they appear to have significantly affected results, this is noted.

All jobs and workplaces should be designed to suit a wide range of physical and psychological capacities and limitations, consistent with those of the workforce (Pheasant, 1996; Rohmert, 1987), since mismatches between demands and coping capacity will increase the rate of errors (Reason, 1990), the amount of effort required and consequent fatigue, with potentially negative effects on health.

To some degree the importance of innate abilities such as intelligence, and of learnt skills, will vary with the kind of work. For example, in jobs that are highly routine and provide little or no opportunity to exercise discretion, higher intellectual abilities will be largely unrelated to performance, whereas in jobs requiring high levels of verbal, numeric, spatial and or perceptual proficiency, people with higher levels of these capacities are likely to find the situation less demanding (Sdorow, 1990).

While empirical research evidence is scarce in this area, Jex (1998, p.72) argues “there is a strong case that ability can moderate stressor-performance relations.” Payne (1991) gives the example that people with high verbal ability and social competence may be more likely to gather information from their colleagues, facilitating their capacity to cope with demands and enabling them to maintain performance during periods of high workload. Further, he suggested that people with these abilities might appraise the deadlines and challenging assignments as less threatening, knowing they can seek help if required. Greater education and job experience might thus be protective against the potentially negative effects of excessive workplace demands, helping people to more accurately anticipate and deal with impediments and to develop an effective repertoire of coping strategies. Also, well-trained and experienced staff are also more likely to hold more senior positions within their organizations where there are likely to be greater opportunities for control and for undertaking tasks that are satisfying. Finally, experience can help individuals to be more
confident and competent in coping with interpersonal relationships and possible conflicts, and so more stress resistant (Cooper & Bright, 2001; Jex, 1998). However, if the selection processes used to determine the ‘person-job fit’ and the subsequent training of incumbents have both been appropriate, differential intellectual abilities should not be critical to people’s coping capacity.

Personality variables influence patterns of work behaviour, attitudes to the job and relationships with others at work (Green et al., 1991). There is evidence suggesting that certain personality traits and dispositions may influence feelings about and appraisal of work demands, whether by moderating (reducing or increasing) reactivity or bolstering (protecting) people during periods of workload mismatch and the resulting stress (Cox, Griffiths & Rial-Gonález, 2000). The personality traits most commonly linked to coping capacity are ‘locus of control’, neuroticism or negative affectivity, extraversion, openness, agreeableness and conscientiousness (e.g. Cohen & Edwards, 1988; Eysenck, 1953, 1991; Jex & Spector, 1994; Reich & Zautra, 2002; Sanderson & Woods, 1987). Those who tend towards negative affectivity and neuroticism are more likely to react badly to high demands (stressors), indulging in self-blame, wishful thinking, and passivity (Costa et al., 1996). Further, individuals scoring high on negative affectivity are more likely to experience distress, and to be dissatisfied with their work tasks and relationships as they tend to expect and look for negative aspects of situations in others and themselves. As a result, they have somewhat poorer workplace relationships, higher absenteeism and psychosomatic distress rates (Chen & Spector, 1991; Cropanzano & James, 1993; Watson & Clark, 1984). Costa, Somerfield and McRae (1996) found that those high on extraversion talked more with others (perhaps seeking emotional-focused or cognitive problem-focused support), those high on openness sought solutions, assistance and advice from others (a cognitive problem-focused approach), and those high on conscientiousness persevered in difficult situations using situational reframing (cognitive appraisal-focused approach).

Jex and Bliese (1999) and others (Leiter, 1991; Kinicki & Latack, 1990) have reported evidence that both individual and collective (group) self-efficacy moderates relationships between workplace demands and individual stress levels. Individuals with high self-efficacy levels are reported as more likely to use problem-focused adaptive coping strategies, whereas those with low self-efficacy tend to use emotion-focused strategies and react more negatively to stressors or less favourably to positive environments.

With increasing age, mean levels of individuals’ physical strength, flexibility, endurance and rate of recovery from injury tends to decline. Other normal changes associated with increasing age include
slowing in information processing rate and resultant response times, so that people are working at
closer to their performance capacity limits – especially when there are time pressures (Comcare,
2003; Hagberg et al., 1995; Matthews et al., 2000; Rodahl, 1989). However, increasing age is also
associated with greater experience and perhaps also with higher skill levels, organisational seniority
and associated job control (Comcare, 2003; Cooper & Bright, 2001).

Finally, an individual’s capacity to cope with work demands may be influenced by the ‘spillover’
effects from other domains, such as their home life – particularly the demands they experience
there and the support they receive. Employees experiencing high family demands may be more
stressed, less satisfied, not as committed to their employer and have higher absenteeism (Brisson,
1999; Duxbury & Higgins, 2001). Similarly, high demands related to caring for older family
members has been associated with increased work stress (Duxbury & Higgins, 2001; Lee, 1997).
On the other hand, evidence of ‘positive spillover’ has also been reported. For example, greater
emotional support at home was associated with increased ability to deal with work stress (Repetti,
1987); good marital relationships were associated with higher job satisfaction (Barling &
Rosenbaum, 1986), as was satisfaction with childcare (Hurrell & Ridley, 1975).

Social and Management Support

An individual’s ability to cope with demands, and their motivation to do so in the face of
challenges, will be significantly affected by the kind and level of support that is available to
them. Accumulating empirical evidence of the importance of support as a potential moderator of
occupational stress led Johnson and Hall (1988) to include it as the third major job characteristic
in their Demand-Control-Support Model. Since then its importance has been confirmed by many
researchers (Ahlberg-Hultén, Theorell & Sigla, 1995; Baker et al., 1996; Hall et al., 1993;
Landsbergis et al., 1992, 1994; Stansfeld et al., 1998; Vermeulen & Mustard, 2000). Support
will only be effective if it is in a form that reflects the specific needs of that individual and
situation and, in the case of interpersonal support, if it is provided by someone believed by the
recipient to be both competent and trustworthy (Baker et al., 1996; Sauter, Murphy & Hurrell,
1992; Tetrick, 1992). It is likely that people can benefit by receiving, at different times, a range
of different kinds of support.

Support from supervisors, co-workers and managers or the organisation more generally, has been
categorised in several different ways (Jex, 1998; Baker et al., 1996; Cohen & Wills, 1985;
Rhoades & Eisenberger, 2002). However, there are substantial overlaps between these somewhat
arbitrary categories.
Emotional support (sometimes termed social support) refers to support provided, for example, by
people listening, expressing concern, giving reassurance or communicating empathy, which can
help to ‘bolster’ people’s emotional coping capacity (Cohen & Wills, 1985). Emotional support
can also be derived from positive feedback and personal affirmations from others, which also
provide some information about work behaviour. Validation of people’s work performance and
of their self-worth by others can also be viewed as an important (non-financial) reward for effort,
and while not always approved of by managers, the opportunity to socialise intermittently with
others can help to make boring jobs more tolerable. It should be noted, however, that there is
significant variability in the amount and type of emotional support that people might need or
desire (Greller et al., 1992; Kalimo & Smith, 1997; Landbergis, 1994; Landsbury & Spillane,
1991; Morrison et al., 1996; Tetrick, 1992).

Emotional support is comforting and can help to ‘bolster’ people’s affective state. It does not,
however, reduce the objective level of demands with which they have to cope, and might not
even influence the perceived level of such demands. To the extent that it is helpful, such support
probably is effective mainly by reducing the perceived negative probability and/or outcomes of
failure to cope. In contrast, instrumental and informational support can directly reduce the
overall demands with which people have to cope.

Instrumental support refers to the provision of tangible material assistance, and this can directly
reduce demands. Just knowing that people will help if needed does not reduce actual demand,
but it is likely to reduce the perceived probability of failure to cope. Informational support in the
form of access to necessary information, guidance and training (especially when new equipment
and or procedures are introduced) can both reduce work demand (by reducing uncertainties) and
increase individual coping capacities (Searle, Bright, & Bochner, 2001; Spector, 1996). Both
instrumental and informational support can help to reduce the effort required to do a job, and
they are sometimes categorized as a single type of support. Timely and clear feedback on
performance is an important kind of informational support, and has the potential to improve
performance significantly.

Whether it is perceived as support, or as another source of demand or pressure, is likely to
depend upon the content of the feedback (positive or negative), the manner in which it is given, as
well as on the recipient’s attitude to the person delivering it (Deelstra et al., 2003).

Closely related to informational support is that of appraisal support where others help the person
‘re-evaluate’ the situation so that it is perceived as less threatening. This kind of support can help
to reduce distress, but again, the extent of its effect will be dependent on whether the person delivering it is trusted and respected (Deelstra et al., 2003).

To varying degrees, most people conduct their work as members of a team rather than in isolation. When people have to work collectively – as a team – to achieve work objectives, effectively functioning teams have been found to be cooperative and friendly, with team members serving as important sources of emotional, instrumental and informational support for each other during periods of high workload. Dysfunctional teams, and dysfunctional workplace relationships more generally (especially where there is overt interpersonal conflict), increase the effort needed to complete tasks, partially because they disrupt effective communication and task-related behaviours, and can add significantly to workplace stress levels (O’Driscoll & Beehr, 1994).

Against this backdrop, people’s own workloads have been found to influence their organizational ‘citizenship’ behaviour. The more tired, stressed and dissatisfied people are, the less willing they are likely to be to use their limited time and energy to provide support to others in the team (Cropanzano, Rupp & Byrne, 2003).

**Physical Working Environment**

Adverse physical environmental conditions can significantly reduce people’s ability to cope with work demands, as well as potentially detract from their comfort, health, safety and satisfaction.

It has been well documented that workspace designs that are ill-matched to users’ anthropometric and biomechanical characteristics can not only increase the physical demands of the work but also increase the risk of injury, and of performance errors (Sanders & McCormick, 1992; Pheasant, 1996).

Poor lighting levels, high reflectance and glare can all seriously reduce peoples’ abilities to discriminate and attend to visual signals (Howarth, 1990; Klitzman & Stellman, 1989; Sanders & McCormick, 1992). As most tasks have a visual component, this means that users are likely then to position themselves in physically awkward positions to ensure that they can see what they are doing.

Very noisy environments are detrimental to employee wellbeing and can lead to Noise Induced Hearing Loss (NIHL) – a disability that causes significant distress, social isolation and economic loss (NOHSC, 2003). Noise is also a potent stressor leading both to immediate symptoms (irritation, frustration, increased blood pressure) and to long-term health consequences (e.g. NIHL,
tinnitus, increased CVD risk). Even low levels of noise can be a problem if they inhibit communication and thus contribute to social isolation in the workplace (Abel, 1990; Melamed & Bruhis, 1996; Mike et al., 1998).

The health, safety and performance implications of working in unpleasant or extreme thermal environments are widely acknowledged. Unpleasant thermal conditions can be a significant cause of stress, fatigue, discomfort, and dissatisfaction and in extreme situations can even threaten survival (for a recent review see Hancock & Vasmatzidis, 2003; also, Hancock, 1981; Parson, 1990; Razmjou, 1996; Luczak et al., 1993).

Exposure of the whole body or of specific body parts to vibration has been linked with a range of health effects including disrupted functioning or injury to the following systems: vestibular (Seidel and Heide, 1986), musculoskeletal (Hagberg, 2002), circulatory, neurovascular (Bonney, 1990; Griffin, 2004), digestive, female reproductive and male urogenital (Seidel and Heide 1986). Importantly, vibration can also impede performance by interfering with people’s vision and motor control, and possibly also information processing performance in the case of complex tasks⁵ (Bonney, 1990; Hagberg, 2002; Huey & Wickens, 1993).

While the exposure to toxic substances and hazards can directly affect health, it can also act via indirect pathways as “real or perceived exposure to hazardous materials” leading to stress and to poorer psychological wellbeing (Kovalchick et al., 2002). In the office environment in which the present studies were conducted, exposure to significant noise, extreme thermal conditions, vibration and hazardous substances would not be common.

**JOB CONTROL AND VARIETY**

A wide range of other job-specific factors may influence ‘workload’ and related wellbeing, the most important of which is the broad construct of ‘Job Control’ (Baker et al., 1996; Hockey et al., 1989; Kalimo, Lindström & Smith, 1997; Karasek & Theorell, 1990).

Job control has been defined as

> the ability of a person to exert some influence over one’s environment so that it becomes more rewarding or less threatening” (Ganster, 1989, p.3).

In Karasek’s Job Demand Control Model, ‘job control’ is given the same status as ‘demand’. Control is operationalised within that model as the combination of decision latitude and the

---

opportunity to use and develop skills on the job, or *skill utilization* (Karasek, 1979; 1989.). From a practical perspective, there are several different types of job control relating to decision latitude, as outlined below.

*Task Order Control* where the person can to some degree choose the order in which tasks for which they are responsible are completed and even the work method used (as long as performance standards are maintained) is of special interest in the consideration of workload. During busy periods, individuals with discretionary control over how they work may choose to perform tasks sequentially, simultaneously or alternately. While sequential ordering of tasks will decrease the immediate task workload and improve quality it will delay the completion of other tasks; whereas concurrent task scheduling may result in poorer quality especially if the tasks require the same cognitive and physical resources; and finally alternating between tasks demands additional time and effort especially if it involves moving from one stimulus response modality to another (Broschott *et al.*, 1994; Kalimo & Smith, 1987).

*Work Rate and Pace Control* refers to the degree to which the person can decide their overall or periodic performance work speed and has the ability to take discretionary rest breaks (rather than this being under external or machine control). This type of control has a fairly direct effect on the task and job demands experienced. The failure to be able to control one’s own work rate and pace to allow for decreasing performance capacity due to fatigue, or give time to recover from errors is stressful (Levi, 1989).

As early as 1965, Kornhauser’s study of automobile assembly workers suggested that the inability to control work pace was a stressful experience. Johansson *et al.* (1978) in their comparison of machine-paced and self-paced jobs in a sawmill showed that machine pacing was associated with higher levels of catecholamines – a physiological indicator of increased stress. Wilkes *et al.* (1981) study of machine-paced poultry inspectors showed that those whose whole job was based at the assembly line had the highest job stress and number of health complaints. More recently the same issue has begun to emerge as a source of pressure and stress for call centres workers (who often have the same external pressure on their work pace created by overhead ‘customer waiting displays’ and through the imperative to meet timed production quotas) (Bultmann *et al.*, 2002; Friedman, 2002; Fornes *et al.*, 1994; Jackson *et al.*, 1993; Mullarkey *et al.*, 1997).

*Work Scheduling Control* is the degree to which the operator can (within limits) choose; shift schedules which suit their individual needs and preferences, have some flexibility around their starting and finishing working hours, have the capacity to have access to and use flexible working
arrangements such as flextime and to choose when to take recreational leave entitlements. This type of control is typically less available to blue-collar workers and in times of high underemployment where employers can more easily dictate working conditions (Broschott et al., 1994; Karasek, 1989; Kalimo & Smith, 1987).

Control over the physical work environment such as desk height, level of light, temperature, and or noise to suit their individual preferences are important issues for many employees. Glass and Singer (1989) indicated that it is the perception of physical environmental control opportunities that the employee has rather than the level of control itself that is important when they demonstrated that the negative effects of noise on performance could be reduced if operators believed they could turn off the noise if they chose to (Glass & Singer in Hockey et al., 1989).

Interaction control (the ability to decide the amount and timing of social contact) is especially important in those sectors such as the human service and health sections in order to control the risk of burnout. The ability to choose how much interaction with others occurs usually increases with seniority (Baker et al., 1996; Carayon, 1993; Ganster, 1989; Karasek & Theorell, 1990).

Finally, the ability to leave their current occupation or employer and successfully seek work elsewhere (career mobility) allows important psychological control if work conditions continue to be unsatisfactory (Baker et al., 1996; Carayon, 1993 Ganster, 1989; Karasek & Theorell, 1990).

Hockey et al. (1989) developed a control model of stress regulation which explained this process in terms of people gaining greater control over their workload levels. In jobs where staff have high ‘control’ they can use a wider range of alternative performance strategies to decrease demand and thereby avoiding stressfully high workloads, or to choose to increase demand and thus avoid stressful boredom (Macdonald, 2003). The relationship between job control and workload is consistent with more recent research by Carayon & Zijlstra (1999) showing that when the effects of different types of control are analysed separately, higher levels of instrumental control (relating to influence over task factors such as amount and rate of work, which would directly influence workload) are related to lower levels of ‘work pressure’, whereas higher levels of decision control (relating to influence over organisational processes, procedures and policies, which might be associated with greater responsibilities without any counteracting decrease in demand) was related to higher ‘work pressure’. Van Der Doef and Maes (1999) concluded from their major review of evidence that only aspects of job control that correspond to the specific demands of a given job moderate the impact of high demands on wellbeing. In reviewing these findings, Macdonald
(2003) emphasised the importance of identifying and assessing the demands specific to particular tasks and jobs, in order to manage workload, stress and wellbeing more effectively.

Employee *participation* in decision-making and influence over the development of organizational policies, goals or procedures is a subsidiary aspect of the larger concept of job control. At the most basic level employee *participation* will be when staff are involved in decisions about their own work tasks and work rates (Greller *et al.*, 1992). Appropriate job level involvement in decision-making reduced uncertainty, thereby improving performance and lowering conflict (Blewett & Shaw, 1995; Marmot, 1994; Parker & Wall, 1998).

Where there are few opportunities to participative decision-making and control over the quantity and work rate (such as in factories where there are machine-paced assembly lines) employees report the highest level of anxiety, depression and irritation and more somatic complaints. This is illustrated by Macdonald (2003b, 2003c) work rate study where there was evidence that participation in setting the work rate to some extent counteracted the negative effects of machine or external pacing (see also Johansson, 1981; Shikdar & Das, 1995). While involvement at job level participation is relatively common, especially in white-collar areas, in most companies it would rarely include employees in strategic decision-making about the way the organization is structured and run (Jackson, 1983 in McCormick and Ilgen, 1987).

There are usually organisational reasons for lack of employee participation in decision-making including: lack of opportunity to influence decision-making beyond the task job level; management failing to act on employees’ suggestions; poor organisational structures which do not allow employees to follow through on decisions on their own; and no arrangements for employees to participate (in decision-making exercises) without negatively affecting their own JobLoad (for example returning to their work point and then needing to expend additional effort to catch up on missed work). However the benefits of employees participating in the general management of their own work and workplace and their own wellbeing have been well documented, particularly in terms of scores on the ‘control’ dimension of the Karasek model (e.g. see Karasek *et al.*, 1998).

Other types of job characteristic have been identified which are important, particularly because of their influence on workers’ motivation and willingness to expend effort. A seminal theory in this regard is the Job Characteristics Model (JCM) of Hackman and Oldham (1976; 1980). According to the JCM there are five core job characteristics – skill variety, task identity, task significance, autonomy, and feedback – which influence the individual’s ‘critical psychological states’. These
job characteristics and personal states collectively promote personal and work outcomes in the form of work-related motivation and satisfactions, which in turn influence absenteeism and turnover. While there is some evidence that inclusion of ‘critical psychological states’ within the model is unnecessary, the validity of the five core job characteristics and their influence on job satisfaction is well established (see Fried & Ferris, 1987 review and meta analysis of the model).

The Demand-Control-Support model embraces the importance of some of these key work characteristics – particularly skill utilization, which includes the further development of existing skills and the development of new ones, which is both motivating and contributes to the person’s ability to exert control over his or her working situation. Jobs that provide opportunities for active learning and that allow a desired level of creativity have been associated with employee feelings of mastery and pleasure (Baker et al., 1996; Karasek, 1979; Karasek & Theorell, 1990).

Jobs with poor ‘job content’ characterised by: insufficient or excessive numbers of highly fragmented tasks, short highly repetitive work cycles or insufficient task rotations; little use of operator’s skills and creativity; tasks with perceived low significance and importance to others are associated with higher levels of stress and dissatisfaction (Cox and Griffiths, 1995; Kalimo et al., 1997; Landy, 1992; Hurrell & McLaney, 1988; Narayanan, Menon, & Spector, 1999; Rissler, 1979; Sauter, Murphy & Hurrell, 1992; Landsbury & Spillane, 1991).

Reasonable variations in overall workloads (‘peaks and troughs’) can be valuable. Periods of high workload may offer a challenge to workers to maintain performance during busy periods which, in boring tasks, may make the job more interesting. Alternatively, periodic quiet times can be valued opportunities for recovery, undertaking preparatory work, socialising, and supporting others (French et al., 1982). However, highly irregular and unpredictable variation in workload, especially when they are largely outside the control of the person experiencing them, may be experienced as distressing (Cooper et al., 2001).

SUMMARY

In this chapter, ergonomics research literature on the nature of workload as a multidimensional construct was critically reviewed, and the main determinants of workload identified. These can be categorised in relation to job characteristics, work demands, support, physical environment factors, SPPCA and personal characteristics. From this review, it was evident that a conceptual model which encapsulates the workload of whole jobs, as opposed to individual tasks, has not yet been developed. The development of such a model is necessary to support more effective assessment,
evaluation and management of job-related workload levels in order to enhance occupational health and safety (OHS). The model needs to incorporate all major factors that have been identified within the literatures of cognitive ergonomics, human factors psychology, organisational psychology and OHS as having a significant potential to influence job-related or ‘occupational’ workload levels.

Accordingly, one of the objectives of this thesis is to formulate a conceptual framework for this purpose, termed the ‘JobLoad Model’. Central to this framework is the ergonomics concept – not previously applied within the context of occupational workload measurement and management – that work and job designs should ensure an optimal match between work demands and broader job characteristics on the one hand, and the person’s coping capacity on the other, as assessed dynamically in relation to incumbents’ job performance rather than in relation to the more static ‘match’ between job requirements and the characteristics that different individuals bring to a job, of the kind typically evaluated when employees are initially selected for appointment to particular jobs.

Within the present model, an individual’s performance capacity and perceived adequacy has a central role, consistent with the ergonomics concepts of ‘workload’ which emphasises the demands experienced by people during performance of their jobs. There is a clear parallel here with the concept of ‘cognitive appraisal’ that is central to transactional concepts of occupational stress, of the kind commonly used within the domains of organisational and occupational health psychology. However, perceived workload differs from stress in that it is not inherently a negative experience, and even very high levels of workload might be perceived positively rather than as stressful.

In the following chapter, the general nature and specific dimensions of employee wellbeing as they relate to workload are discussed.
EMPLOYEE WELLBEING AND PERFORMANCE

In chapter 2, a model of the various determinants of job-related workload (‘jobload’) was presented. These determinants include work demands and other relevant job characteristics such as control and variety, coping capacity (influenced by both individual and external factors), self-rated employee performance, and employee wellbeing. According to this model, a poor fit between demands and coping capacity is likely to degrade employee perceptions of their own performance capacity and adequacy, with consequent negative effects on their wellbeing. Some job characteristics can affect work demands and/or coping capacities and therefore indirectly influence individual wellbeing, as well as possibly influencing wellbeing directly.

The focus of Chapter 3 is the nature of employee wellbeing, including discussion of those specific aspects of wellbeing that were measured in this project. The role of self-perceived performance adequacy is then reviewed, since the Jobload Model identifies this as a key variable intervening between work demands and wellbeing. It should be noted that a comprehensive and critical review of the vast body of literature on work-related wellbeing – including current models of occupational stress and its key determinants – was beyond the scope of this thesis. Rather, it is the purpose of this chapter to provide a descriptive account of those aspects of wellbeing that were of greatest interest in relation to job-related workload.

THE NATURE OF WELLBEING

Introduction
Health – both physical and mental – is an important aspect of overall wellbeing; people who are either physically or mentally ill are generally seen as having lower levels of wellbeing than those who are not, all else being equal. The present project is concerned with the wellbeing of people at work; in this population, the great majority of people are ‘well’ in that they do not suffer from significant illness. However, the World Health Organisation views health very broadly, defining it as “a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity” (WHO, 1948). Based on this definition, the absence of specific injuries or diagnosed physical or mental illnesses does not mean that wellbeing is at an optimal level.

The terms ‘mental health’ and mental or psychological ‘wellbeing’ are sometimes used interchangeably, despite their different connotations. Most commonly, ‘mental health’ implies
simply a freedom from mental illness; that is, freedom from conditions that are clinically diagnosable based on DSM-IV-TR (American Psychiatric Association, 2000). However, the distinction between mental illness and a low level of psychological wellbeing is not always clearcut. Prolonged exposure to high levels of environmental stressors may result in a range of negative psychological states including feelings such as anxiety, hostility, confusion, and hopelessness, which in vulnerable individuals can provoke psychiatric conditions such as anxiety disorders, psychosis, and depression. Some conditions have been defined in terms of the types of events believed to cause them. At a sub-clinical level, ‘burnout’ has been identified as a condition where there is prolonged response to chronic emotional and interpersonal stressors on the job which result in exhaustion, cynicism, depersonalisation, and erosion of motivation, caused by chronic feelings of powerlessness to influence and accomplish the job’s goals (Bourbonnais, Comeau, Vezina, & Dion, 1998; Cox, Kuk & Schur, 1991; Densten, 2001; Maslach, 1993; 1998; 2003; Leitter, 1991). At a clinical level, ‘post-traumatic stress disorder’ can develop following exposure to a single, highly traumatic event, including being bullied or assaulted, whether by other (possibly very stressed) employees or by clients (Kahn & Byosiere, 1992; Jones & Bright, 2001; Kahn & Byosiere, 1992; Taylor, Repetti, & Seeman, 1997).

In many workplace injury databases, sub-clinical and clinical states are not well differentiated; for example in Australia the current classification of mental disorders used in the National Data Set for Compensation-based Statistics (NDS 2001-02) includes within the single category of ‘Mental Disorders’ states such as “stress”, clinically diagnosed mental disorders such as “depression” or “obsessive compulsive disorder”, symptoms of distress such “hyperventilation” and even possible causes of these conditions such as exposure to “workplace violence”. However, the present project is concerned with wellbeing states that are within the normal workplace range, rather than with specific clinical disorders.

Ryan and Deci (2001) observed that research on wellbeing falls within two distinct but overlapping paradigms. The first of these is the “hedonic approach” in which wellbeing is assessed by the researcher using subjective measures of affective state or mood, and of life satisfaction (Diener & Lucas 1999; Kahneman et al, 1999). The second approach is termed ‘eudaimonic’; within this paradigm, wellbeing is a function of the degree to which a person is “actualizing their full potential” by engaging in personally meaningful and valued activities (Maslow, 1943; McGregor & Little 1998; Ryff 1989; Ryan & Deci, 2000; Waterman 1993). In view of the workplace context of the present study, the ‘hedonic’ approach was seen as more appropriate here.
There is consensus that hedonic ‘wellbeing’ is multidimensional, with components related to affective state and to cognitive appraisal of the satisfactoriness of the overall situation, which in the present context relates to the individual’s job. Within the work-specific framework of the JobLoad Model, the individual’s perceived capacity to perform their work satisfactorily is an important determinant of wellbeing. Siegrist (2003, p.2) also includes “satisfaction with …….. functioning” within his view of wellbeing. Specifically, he described wellbeing as reflecting “people’s judgments”. These “judgements concern their enduring mood (e.g. happiness) as well as their evaluation of the self (e.g. satisfaction with one’s physical and mental health and functioning) and its relation to the material and psychosocial environment (e.g. life satisfaction, work satisfaction)”. Importantly, he argues that “mood reflects the perceptions and evaluation of an individual’s affective state”, but satisfaction involves cognitive judgements about the situation which are “based on some standard of comparison” and are influenced by “discrepancies between expectation and real experience” (Siegrist, 2003, p.2).

The research literature on ‘wellbeing’ is primarily concerned with psychological wellbeing, but the concept of physical wellbeing differs in some ways from this. It is easy enough to define low levels of physical wellbeing – that is, physical injury or illness, but examination of the idea of high levels of physical ‘wellbeing’ confirms the basically psychological nature of the ‘wellbeing’ concept. Thus, high physical fitness and muscular strength reflect performance capacity rather than wellbeing in the normal sense; similarly, an individual whose immune system is functioning optimally is highly resistant to illness rather than necessarily at a high level of wellbeing. The closest approach to a state of high physical wellbeing seems to be the state termed ‘vigour’ (Daniels, 2004; Russell, 2003; Shirom, 2003); however this is characterised by ‘positive affect’, ‘emotional energy’ and ‘cognitive liveliness’ in association with high levels of ‘physical strength’, which makes it a psychological state as much as (if not more than) a physical one. Importantly within the context of the JobLoad Model, feeling ‘vigorous’ is likely to influence how people perceive the match between work demands and their coping capacity. It may also enhance performance itself because people may be more willing to expend effort (Frederickson, 2002).

Warr’s concept of psychological wellbeing encompasses both affective (mood) states, and cognitive judgements of situations as more or less satisfying. It is affected by people’s own ‘aspirations’, desires for ‘autonomy’, ‘functioning’ and perceived ‘competence’ (1999, p.393). His earlier two-dimensional model of wellbeing, depicted in Figure 3.1, has orthogonal axes termed ‘arousal’ and ‘pleasure’ (see Warr, 2002). Intensity of emotion is represented by the distance from
the centre of the circle. Within this framework, a wide range of affective states can be seen to arise from different combinations of either positive or negative affect or varying arousal levels.

Figure 3.1. Two-dimensional view of psychological wellbeing (Warr, 2002, p.2 material reproduced with permission)

In a later, three-axis development of this model, two diagonal axes replace the vertical axis of the two-axis model (Warr, 1999, p.394; 2002, p.3). These two diagonals represent anxiety-comfort and depression-enthusiasm. Recently Warr (2003, p.4) included a fourth possible axis (see Figure 3.2) representing ‘fatigue-vigour’ identified as part of wellbeing by Daniels (2004, 2000), Russell (2003) and Shirom (2003). Wellbeing may then be characterised in terms of its location on each of these five main conceptual axes (see Figure 3.2), which allow for qualitative differences amongst the major categories of affect.
In Australian workplaces it is relatively unusual for data about individual wellbeing, whether psychological or physical, to be routinely documented (except in special circumstances – e.g. the physical health and fitness of commercial pilots). The prevalence and severity of physical symptoms might be recorded and an absence of symptoms perhaps taken as an indication of wellbeing; however it seems (from informal observations) that few workplaces routinely document more positive states. Currently, the focus of OHS legal requirements is on avoiding physical harm rather than promoting either health or wellbeing. An absence of workplace hazards is inadequate in itself to achieve optimal employee wellbeing, but it protects against harm, which is a pre-requisite for this.

Warr’s (1987) ‘vitamin model’ depicts work as promoting psychological wellbeing via provision of opportunities to exert control and to experience social support, and by enhancing feelings of self-efficacy via the experience of success. Consistent with this, employment (as opposed to unemployment) has been shown to help protect against future psychiatric morbidity (Stansfeld et al, 1999). On the other hand, there is ample evidence that poorly designed work can cause physical or psychological harm. Recent research by Katwyck and colleagues (2000) concluded that work-related wellbeing is best represented by a two-dimensional structure reflecting basic variables of pleasure-displeasure and arousal level. However, the nature of these two dimensions differs from those of Warr’s two-axis arousal-pleasure model. In this later research, one axis is a continuum of ‘pleasant’ states, and the other is a continuum of unpleasant states; within each of these axes there is variation from low to high arousal.
Separately from the research on ‘wellbeing’ outlined above, another very large body of research and measurement has focused on work-related ‘satisfaction’. This aspect of wellbeing is not usually associated with mental health; more typically it is associated with ‘morale’ and sometimes also with the quantity or quality of work performance (e.g. Cotton & Hart, 2003; Jex, 1998; Judge, Thoresen, Bono & Patton, 2001; Siegrist, 2003).

Whereas general psychological wellbeing is an affective state, satisfaction involves a cognitive dimension that is “judgments about one’s life conditions which is based on some standard of comparison”. These “cognitive judgments point to existing or non-existing discrepancies between expectation and real experience” (Siegrist, 2003, p.2). Judgements about the adequacy or satisfactoriness of aspects of the work itself, people, organisation, and rewards for efforts will in turn be associated with a hedonic state. Satisfaction level has the potential to affect work-related motivation, with possible impact on a range of work behaviours including performance of core duties, and more particularly, performance of discretionary activities, absence from work, and staff turnover (Warr, 2002).

**Wellbeing in the Context of the JobLoad Model**

The focus of the JobLoad Model is on performance and its self-perceived adequacy: investment of physical and psychological effort in performance tends to increase both arousal and fatigue; the perceived risk of not coping adequately with work demands may result in stress, and/or (dis)satisfaction. Wellbeing (particularly stress and satisfaction) will also be influenced by other aspects of the work and job that are experienced as stressful and/or satisfying.

Accordingly, work-related wellbeing within the context of the JLM is regarded as a personal state that is characterized by reasonable harmony between, on the one hand, the individual’s physical, mental and emotional abilities, needs and expectations, particularly as they affect coping capacity, and on the other hand, work demands and job characteristics (particularly those affecting control and skill utilisation).

- First, the process of performing work inherently demands effort, to an extent dependent on the balance between work demands and the individual’s coping capacities. This tends to increase **arousal** level and also to induce **fatigue** – both physical and psychological – which in turn reduces coping capacity if there is insufficient recovery time.

- Second, work performance and other experiences at work influence people’s **affective** states – both positive and negative. Affective state is here measured by a Stress scale, with
additional information from the scales measuring Wornout and Job Satisfaction. Within most conceptual models arousal in its ‘purest’ sense is affectively neutral, but it is a major dimension of ‘vigour’ and so can be seen as an element influencing affective state.

Third, job satisfaction is seen as resulting from the individual’s cognitive appraisal of their own work-related affective state and more general situation at work. Factors influencing this appraisal are likely to include their own perceived work performance, affective state, and those job and other workplace factors which are perceived as influencing wellbeing. Thus, satisfaction is viewed as having both cognitive and affective elements. Satisfaction can influence performance via its likely effects on goal orientation, related performance strategies, and willingness to exert effort.

The above view is consistent with that of Schwartz & Strack (1999), who saw wellbeing as the “individual’s current evaluation of her [his] happiness” (p.61). According to this view, while people experience their own wellbeing as an affective state, it also reflects their evaluation of its satisfactoriness. In looking at ‘job-specific wellbeing’, Warr (1999,p.393) focused more on the affective dimension, referring to it simply as “people’s feelings about themselves in relation to their job”.

AROUSAL

Work performance is central to the JobLoad Model. The person’s arousal level is therefore a key element of wellbeing, since it affects an individual’s performance capacities and adequacy, and is also affected by perceived level of work demands and indeed by performance itself. As explained in the previous chapter, a person’s ‘arousal’ level can be defined and measured in terms of the degree of activation of their sympathetic nervous system; this is both an essential requirement for, and also an outcome of, work-related activity (Hockey, 1997; Kahneman, 1973). While we are not able to influence sympathetic nervous system activity voluntarily, motivation can help to initiate, maintain and regulate arousal through increased effort (Gaillard, 1993; Kahneman, 1973). Arousal can be viewed on a continuum from extreme ‘under-arousal’ and associated torpor, through moderate levels of arousal where performance is optimal, up to over-arousal with excessive levels of non-functional physical and psychological activity. Varying arousal levels are also associated with different mood states, as depicted for example in Figure 3.1-2 above.

Patterns of arousal or ‘energetical activation’ are automatically stimulated in certain situations (Hockey, 1997), and as stated above, arousal is affected by perceived level of work demands and
by performance itself. Many workplace and individual variables might therefore influence its level, including those depicted in Figure 2.5 within the Work Demands, Job Control and Variety and Coping Capacity categories. Higher levels of work demands might elicit greater effort to sustain performance (Kahneman, 1973; French et al., 1982), and so be associated with result in higher arousal levels. Or, in work environments where there are many factors representing impediments or constraints to performance (e.g. conflict, uncertainty about the work requirements or faulty equipment), additional effort might also be needed with resultant higher arousal (O’Connor & Peters, 1984).

However, the relationship between job factors, arousal, and positive or negative affect can be complex and difficult to predict. For example where there is high decision latitude and/or the opportunity to exert some influence over organizational decisions, jobs will be potentially more demanding in which case they would be expected to have higher arousal levels. However, whether or not this is perceived as stressful, or as interesting and potentially satisfying, will depend on a variety of factors, including whether or not demands remain within overall coping capacity (overall capacity, based on organisational resources as well as those of the individual). In some jobs the presence of low decision latitude might act as an impediment to performance, increasing the effort required and consequent arousal, along with possible stress and/or dissatisfaction. On the other hand, if job demands are perceived as impossibly high, a person may simply ‘give up’ with consequent reductions in effort, arousal level and probably also in satisfaction. In this event, effects on their affective state would be dependent on the perceived consequences of such behaviour. If they anticipated possible negative consequences they might experience anxiety; if not, they might feel just bored, and perhaps also tired – associated with their low arousal level (Soames-Job & Dalziel, 2001; Scerbo, 2001).

Job designs to enhance wellbeing need to ensure that people have sufficient variety of tasks, so that the overall job entails the development and application of a range of different mental and physical abilities and skills. This will help to avoid monotony and boredom, thereby sustaining arousal levels and addressing a common cause of stress and dissatisfaction (Karasek, 1990; Warr, 1997). Tasks with higher levels of physical activity (such as walking and carrying) are more physiologically arousing that those that are more sedentary in nature. Tasks that require a high level of perceptual/cognitive ‘vigilance’ to ensure adequate performance are typically sedentary, which is de-arousing. To maintain arousal at a sufficiently high level to support adequate
performance of such ‘vigilance’ tasks, it is advantageous if the work can be designed to incorporate intermittent physical activity (Cooper et al, 2001; Scerbo, 2001).

Relationships between arousal level and the ‘support’ factors are difficult to predict. According to the Demand-Control-Support model, the presence of high levels of support can help to moderate or reduce demand levels, thus reducing the amount of effort required to complete the work (Baker, Israel & Schuman, 1996). According to Kahneman’s (1973) model, lower demand itself will tend to reduce arousal levels (Kahneman, 1973). However, emotional support and encouragement might stimulate people to exert greater effort and so be associated with higher arousal level (Jex, 1998).

As already noted, arousal in itself is affectively neutral; however, varying levels of arousal combine with positive or negative affect to create 'moods' that are unpleasant or pleasant to varying degrees - as shown for example in Figure 3.1-2 above. Similarly, the four-quadrant model of mood proposed by Gotts and Cox (1988) depicts 'stress' (affect) and arousal as interacting to create different mood states: high arousal combined with high levels of negative affect results in varying degrees and types of anxiety; high arousal combined with high positive affect results in 'pleasant excitement'; low arousal with high negative affect (stress) results in states such as boredom; and low arousal with positive affect (low stress) is typified by 'relaxed drowsiness'. Within this framework, a range of positive wellbeing states exists when affect is positive (i.e. low stress) at all levels of arousal (Gotts & Cox, 1988; Thayer, 1978). Stress and arousal are "predictably and differently sensitive to a number of environmental, task, training and drug effects" (Gotts and Cox, 1988, p.27).

Thinking about arousal and performance has been strongly influenced by the early work of Yerkes and Dodson (1908), who identified a relationship between discrimination learning and aversive reinforcement in mice which later became known colloquially as the Yerkes-Dodson Law. However, it was later researchers (e.g. Broadbent, 1971; Easterbrook, 1959; Kahneman, 1973; Welford, 1973; 1976) who related the “effect of stress on human performance capacity through the introduction of the mediating influence of arousal” (Hancock, Ganey & Szalma, 2004,p.2) (see Figure 3.3). Performance tends to improve with increasing cognitive arousal, but only to a certain point after which increasing arousal is associated with poorer performance.
Figure 3.3. Diagrammatic representation of the Yerkes-Dodson Law (Warr, 2002, p.3 Material reproduced with permission)

In practice, actual relationships between arousal and performance are more complex than depicted by this simple ‘law’, partly because affect is also likely to affect performance. Heightened arousal paired with positive emotion can help to broaden the scope of cognition and enable flexible and creative thinking, which increases people’s tendency to positively interact with others in the workplace and generally to invest greater effort in their work tasks (Carver & Scheier, 1990; Fredrickson, 2002; Shirom, 2003). In contrast, high physiological arousal with negative emotions (stress, anxiety) may be associated with increased but non-productive behaviour (Jex, 1988). When there is a requirement for vigilance and action, low arousal levels may have serious safety and performance implications (Jex, 1996). Further, when people are feeling very tired, the associated low levels of arousal levels will make it more difficult to maintain effort.

Although the autonomic processes that initiate, maintain and regulate arousal are not under voluntary control (as noted earlier), people do regulate their effort and use a range of strategies which indirectly influence arousal (energetic) levels (using stimulants, varying physical activity, taking a break). Building on Kahneman’s model (1973), Hockey (1993; 1997) outlined a model of cognitive-energetical regulation in which he suggested that mental effort is a finite resource and that people will attempt to regulate their effort. As their arousal (energy) declines they will then decide between two broad responses. These are either to:

(a) “invest further mental effort” to maximize performance or

(b) “conserve mental effort”, minimize discomfort and if necessary, sacrifice performance (Hockey, 1993; 1997).
Even if alternative (a) above is chosen, it is clear that eventually the expenditure of effort to sustain performance will attract such a high mental, emotional and/or physiological cost (increasing subjective tiredness; excessive sympathetic and adreno-medullary activation) that performance must deteriorate (Frankenhaeuser, 1986; Hockey, 1997; Kahneman, 1973).

**FATIGUE**

Work performance, which is central to the JobLoad Model, necessarily tends to induce fatigue – both physical and psychological - which in turn reduces coping capacity if there is insufficient recovery time. Fatigued workers are reported to be at increased risk of musculoskeletal and psychological injuries and other health problems (Costa et al., 1996; Dawson et al, 2001; Kumar, 2001; Henderson, 1997; Sparks, 1997; Sluiter et al, 2003).

Fatigue has been variously conceptualised as, amongst other things:

- a non-specific, neurophysiological state – general fatigue (Davis, 1995; Grandjean, 1970)
- bodily changes, such as reduced contractile and force capacity (Dugan & Frontera, 2000; Kumar, 1994, 2001; Rodgers, 1997)
- manifest in psychological and associated performance changes, for example, emotional lability, lack of motivation, disinclination to expend effort, performance deterioration (Brown, 1997, 2001; Cox, 1990);
- manifest in affective state, e.g. feeling of tiredness, through to exhaustion and sleepiness (Mital et al, 1994; Nelson, 1989; Park et al, 2001).

Soames-Job and Dalziel (2001) defined fatigue as a hypothetical construct reflecting the

> “state of an organism’s muscles and viscera, or central nervous system, in which prior physical activity and/or mental processing, in the absence of sufficient rest, results in insufficient cellular capacity or system-wide energy to maintain the original level of activity and/or processing by using normal resources” (Soames-Job & Dalziel, 2001, p.469).

Desmond and Hancock (2001, p.455) used the term ‘active fatigue’ to indicate a state which is derived from “continuous and prolonged task-related perceptual-motor adjustments”, while ‘passive fatigue’ occurs where people are required to monitor systems but where there are rare or even no overt perceptual motor responses expected (vigilance with monotony). Whereas ‘active fatigue’ is due to depletion of energy reserves, ‘passive’ fatigue is due to low physiological arousal.
Both of these fatigue states are ones of reduced coping capacity. In terms of the above definition from Soames-Job & Dalziel (2001), there is “insufficient cellular capacity [active fatigue] or system-wide energy [passive fatigue] to maintain the original level of activity and/or processing by using normal resources”, which in both cases is due to the nature of prior activity. In the current study, both types of work conditions and resultant individual states were considered as potential causes of fatigue, stress and dissatisfaction.

Fatigue can be viewed as ranging along a continuum from no discernable depletion of energetic resources, to one of mild ‘tiredness’ where, with effort, performance can be maintained, to an extreme state where energetic resources are exhausted and further activity is either impossible or likely to result in injury. Fatigue may be localised to different capacities (e.g. physically tired but not mentally tired), to specific body parts (e.g. eye muscles) or be a generalised state (e.g. sleepiness). Fatigue can also be seen as acute but short-term, where there is temporary depletion of ‘energy’ reserves associated with intense physical, emotional or mental activity, or as a chronic state caused by cumulative exposure to excessive demands, usually of a much lower intensity than the demands that induce acute fatigue (Soames-Job & Dalziel, 2001; Pheasant 1991).

Figure 3.4 depicts fatigue-related precursors of work-related cumulative musculoskeletal disorders, stress-related illnesses more generally, and accidents. The states measured within the present project are physical discomfort, ‘wornout’, and stress.

![Proposed influence of fatigue and stress on health and safety](image)

**Figure 3.4. Proposed influence of fatigue and stress on health and safety**

**PHYSICAL DISCOMFORT**

The experience of physical discomfort occurs when states of cellular fatigue, or of underlying mechanical disruption or disorders of the tissues, become discernable to the individual (Kumar, 2001). Such discomfort is often assumed to be on a continuum from no discernable sensation through to extreme discomfort or pain such that the individual is unable to sustain activity, or
continued activity may result in musculoskeletal injury. The nature of this presumed continuum is not well documented (see Straker, 1999). Nevertheless, it is intuitively appealing and widely accepted that, based on a range of mechanisms discussed below, physical discomfort is one of the probable precursors of cumulative musculoskeletal injuries and disorders. Straker (1999, p.1239) observes that “conceptually, discomfort is an attractive risk indicator as it uses the body's own feedback system to detect possible problems.”

All work imposes some degree of physical demand, and these demands figure prominently within research literature on hazards and risk factors for WMSDs (e.g. Ayoub, 1990a, 1990b, 1990c; Bernard, 1997; Buckle & Devereux, 2002; Chaffin, 1991; Dugan & Frontera, 2000; Forde, Punnett, & Wegman, 2002; Keyserling, 2000; Kumar, 2001; Kuorinka & Forcier, 1995; National Research Council and Institute of Medicine, 2001 and others). Review of this literature is beyond the scope of this thesis, but Figure 3.5 (from Kuorinka & Forcier, 1995) summarises much of the evidence. Hazardous physical activities include the maintenance for extended periods of static postures, repetitive movements and/or the exertion of dynamic forces. Being subjected to prolonged vibration (whole body, or a particular body part) or to extremely cold environments can also be hazardous. Virtually all of this evidence relates to hazards for MSDs rather than for discomfort, but as argued above, it is likely that similar risk factors apply to both.

As depicted in Figure 3.5 (Kuorinka & Forcier, 1998), a wide variety of physical, psychosocial and organisational factors have been identified as potential contributors to the risk of work-related MSDs (‘WMSD’ in the figure). In the case of hazardous physical demands, clear dose-response relationships have been demonstrated, and the pathophysiological links between such hazards and injuries are supported by considerable evidence – although the U.K. Health and Safety Executive (2003, Aim K-3) has identified an important need to develop improved understanding of “the pathomechanisms and epidemiology” of WMSDs, including: “studies of the natural history of MSDs with a particular focus on the development of acute versus cumulative/chronic cases”.
As depicted in Figures 3.3-6, there is now strong evidence of the role of psychosocial hazards as well as physical ones, and it is believed that the effects on health of all types of hazard may be mediated via psycho-physiological stress-related mechanisms, as well as directly in the case of physical hazards (Aptel & Cnockaert, 2002; Bongers et al, 2002; Blair, 1996; Buckle & Devereux, 2002; Carayon et al, 1999; Claudon & Cnockaert, Cox and Griffith, 1995; Kuorinka & Forcier, 1998; Macdonald, 2003; 2004; National Research Council and Institute of Medicine, 2001; Westgaard, 1996)

As outlined in the following section of this chapter, the ‘stress response’ has an important physiological dimension. Four possible pathways have been hypothesized by Aptel and Cnockaert, (2002, pages 53-54) to suggest how stress might be associated with increased MSD risk; these are graphically outlined in Figure 3.6 below.
1. **Activation of the central nervous system:** A well documented effect of stress is activation of the reticular formation in the brainstem, associated with generalised physiological ‘arousal’ that, amongst other consequences, results in higher muscle ‘tone’. This increases the “biomechanical load” within muscles and tendons and may thereby contribute to an increased risk of MSDs.

2. **Activation of the catecholaminergic pathway:** Another effect is activation of the autonomic nervous system and stimulation of the adrenal gland with consequent increased levels of catecholamines including adrenaline and noradrenaline. One effect of this is arteriolar vasoconstriction which can impede microcirculation within the muscle bed, tendons and ligaments, hampering nutrient delivery and waste product removal, which in turn results in poorer healing of the microlesions that routinely develop and self-heal during physical activity. As a result, muscular discomfort and pain appear more likely, especially if biomechanical loads are high.

3. **Activation of the adrenal cortex:** Another consequence of adrenal gland stimulation is an increase in levels of corticosteroids. These hormones can disrupt the body’s mineral balance resulting in oedema which further impedes microcirculation and produces local compression of soft tissue structures, which is especially acute if the work requires working in extreme ranges of motion. As a result, an increased risk of syndromes such as ‘carpal tunnel’ would be expected.

4. **Activation of cytokine secretion:** Another dimension of the stress response entails changes to immune system functioning, which include increased levels of circulating pre-inflammatory cytokines, with a likely resultant increased risk of MSDs.

Schleifer *et al*, (2002) suggested a further pathway which was that stress (‘emotional tension’) might also lead to ‘over breathing’ and consequent disruption in the acid-base equilibrium, triggering a chain of systemic physiological reactions including increased muscle tension, muscle spasm, amplified response to catecholamines, and muscle ischemia and hypoxia – all of which have potentially adverse implications for musculoskeletal health.
Figure 3.6. Suggested relationships between some physiological components of the stress response and MSD symptoms (from Macdonald, 2004, after Aptel and Cnockaert, 2002 material reproduced with permission)

Apart from their possible contribution to the development of cumulative MSDs, organizational climate and work context may influence how people perceive, interpret and respond to somatic symptoms (Sauter & Swanson, 1996). Punitive work experiences and related dissatisfaction may alter people’s willingness to tolerate physical discomfort (Andersson et al, 1983; Ahlberg-Hultén et al, 1995; Grimshaw, 2000; Keyserling, 2000; Leino & Hänninen, 1995). It has also been suggested that people who are bored by their work are more likely to have the spare attentional resources and motivation to attend to and report symptoms of physical discomfort that they might have ignored had they been more actively and/or happily occupied (Schleifer, Ley & Spalding, 2002). Devereux, Vlachonikolis and Buckle (2002, p.275) found that workers “exposed to physical and psychosocial risk factors at work, experienced the biological effects of background exposure, high physical exposure, high psychological exposures, and the interaction effects of these two factors”. People exposed to both physical and psychosocial risk factors may be more likely to report symptoms than those who are exposed to high levels of one but not of the other. They also found that “exposure to psychosocial workplace factors may increase risk of symptoms of musculoskeletal disorder… even when the physical demands were relatively low” (Devereux,
Vlachonikolis and Buckle (2002, p.276). This suggests that effective prevention needs to address both physical and psychosocial risk factors.

**WORNOUT**

Psychological fatigue is assessed in this study in terms of how ‘wornout’ people feel. Being ‘wornout’ is a negative state that is operationally defined by the Wornout scale (one of two) of the General Wellbeing Questionnaire (GWBQ). It is characterised by feelings such as ‘tiredness’, ‘cognitive confusion’, and ‘emotional lability’ (Cox and Griffiths, 1990, p.799; Gotts and Cox, 1988, p.27).

The GWBQ was developed for use in occupational rather than clinical settings, with the intention of assessing “the ‘grey area’ between perfect health and obvious illness” (Gotts and Cox 1988, p.27), and was therefore selected as appropriate for the present purpose. Wornout scores typically have correlation coefficients of about .35 to .40 with ‘Stress’ scores from the Stress Arousal Checklist (Gotts & Cox, 1988), but they represent somewhat different states. ‘Wornout’ reflects a general malaise and symptoms of psychological fatigue whereas the ‘Stress’ reflects the affective mood (hedonic tone), and ‘arousal’ the physiological and behaviour states of alertness. Wornout scores have been found to be sensitive to changes in the kind of work and job factors that are measured in this study; for example, Cox and Randall (2003) reported strong associations with quantitative workload, time pressure, impediments to performance, lack of control and consultation, problems with communication during busy times, and perceived job stagnation.

**STRESS**

**Conceptual models**

Based on the cognitive ergonomics concept of ‘mental workload’, the JobLoad Model developed in this thesis focuses on consequences (individual performance adequacy, affective state) stemming from the match between work demands and coping capacity. This approach is highly concordant with that of the ‘Person-Environment Fit’ (P-E Fit) model of stress and wellbeing (Caplan et al, 1975; Hurrell and McLaney, 1988; Kahn, 1981), in which the key determinant of stress is the ‘fit’ between the individual’s characteristics including their motives and capacities.

---

6 At the stage when possible measures were being identified or developed, more recent fatigue measurement scales such Copenhagen Psychosocial Questionnaire (Kristensen, 2002b); Fatigue Assessment Scale (Michielsen, De Vries & Van Heck, 2002); Checklist Individual Strength-20 (Vercoulen, Alberts & Bleijenberg, 1999), and the 10 item Fatigue Assessment Scale (Michielsen, De Vries & Van Heck, 2002) were unavailable.
and both the perceived and objective demands of the job. Their motives may include the desire for economic rewards for effort, and preferred levels of participation and self-utilization; objective demands (‘supplies’) of the job include the quantitative workload and the overall job complexity (Caplan et al., 1975; Van Harrison, 1978; Baker, 1985). Stress is expected to be higher and wellbeing therefore lower when the ‘fit’ between the person and environment is poor (Caplan et al., 1975; Van Harrison, 1978; Baker, 1985).

Based in part on the P-E Fit model, Karasek’s Job Demand Control (JDC) Model (see Figure 3.7), is now one of the most widely utilised. It emphasizes the importance of the interaction between demands and control, and the role that ‘objective constraints’ in the work environment might play. According to Karasek (1979, p.287) work stress and its consequences result "not from a single aspect of the work environment, but from the joint effects of the demands of a work situation and the range of decision-making freedom (discretion) available to the worker facing those demands."

![Figure 3.7. Karasek’s Job Demand Control Model](http://www.workhealth.org/strain/jsdef2.html)

In this model, it is suggested that the greatest risk to physical and mental health and wellbeing are for employees who experience high strain jobs, that is, jobs with high psychological demands and

---

7 http://www.workhealth.org/strain/jsdef2.html
low levels of control (Karasek, 1990). The model predicts that when workers do not have adequate control to enable them to cope with demands, and are not able to use and further develop their skills, they are more likely to exhibit states of passivity and learned helplessness (Karasek, 1989; Marmot et al, 1997), with associated higher stress and lower wellbeing. In contrast, when people have to cope with high demands but have adequate levels of control, as well as adequate opportunities for active learning, they are likely to have greater wellbeing.

Karasek’s original model was expanded to integrate the role of support as a potential moderator of the effects of demand and control on stress and wellbeing. In the Job Demand-Control-Support (JDCS) model proposed by Johnson and Hall (1988), ‘support’ includes factors such as social support. As discussed in Chapter 2, while emotional support is the type most commonly cited, other kinds of support such as instrumental, information or appraisal can make important contributions to the reduction of work-related stress (Deelstra et al., 2003). Consistent with the JDCS model, it has been found that socially isolated workers in "high strain" jobs carry the highest risk of stress and negative health outcomes for workers, and overall, there is now extensive research supporting the view that in workplaces with high demands, low levels of control and low support, people are likely to have higher rates of stress-related health problems (Amick et al, 1998; Gerin et al, 1995; Landsbergis et al, 1994; House et al, 1988, Orth-Gomer et al, 1993; Van Der Doef & Maes, 1999).

Van Der Doef & Maes (1999) suggested that it is important for researchers to identify the specific ‘demands’ and forms of ‘control’ and associated vulnerabilities or needs for ‘support’ of the particular populations they are investigating. They argued that

“only aspects of job control that correspond to the specific demands of a given job can effectively moderate the impact of high demands on wellbeing(Van Der Doef & Maes, 1999, p.108)”.

They suggested that the effectiveness of social support as a buffer against stress depends upon the type and source of the stress, and that social support is probably most effective for those individuals who are “relationship oriented” – a view also expressed by Beehr (1998, p.11). However, as noted by Cummins (1990), the key requirement for effective support is that it is appropriate to the types of demands and stressors with which people are required to cope, so that it meets their needs.
The Effort-Reward Imbalance (ERI) Model developed by Johannes Siegrist (1996) can be seen as complementary to the JDC model, in that it focuses on people’s work-related investment of effort and its perceived consequences, rather than on the factors driving effort expenditure that are the focus of the JDC(S) model. At the core of this model is people’s need for perceived fairness, distributive justice and reciprocity, reflecting an equitable balance between the effort required to perform a job and the rewards offered for this effort (money, esteem, and career opportunities including job security -- see Figure 3.8). This model emphasises the important potential role of work as a source of positive self-esteem, self-efficacy and ‘belongingness’, as well as financial rewards. These beneficial outcomes are contingent on a perceived fair exchange of rewards for efforts. Disproportionately high-cost (highly effortful) work, or disproportionately low-gain (poor rewards for effort) jobs are seen to be particularly stressful, with associated affective and physiological consequences (Peter & Siegrist, 1999, Siegrist, 2003).

![The Effort-Reward Imbalance Model](image)

**Figure 3.8. Effort-Reward Imbalance Model (Seigrist, 1996, 2003 material reproduced with permission)**

Finally, the role of individual variables in the development and expression of stress has been extensively documented. These variables include personal attributes and characteristics such as intelligence, personality and coping strategies (e.g. Myrtek, 1995; Parkes, 1994) and non-work factors such as home demands and home-work conflict (e.g. Hall, 1992; Luecken et al., 1997). However, good management and job design practices should cater for a wide range of such variables (Rohmert, 1987). In the present study, individual factors are treated only as variables to be controlled.
Nature and Measurement of the Stress Response

The potentially serious consequences of chronic stress for health and wellbeing are now well documented (e.g. Biondi & Picardi, 1999; Johnson et al, 1992; Pike et al, 1997; Stansfeld et al, 1997, 1999; Marmot, 1994; Marmot et al, 1997). Linkages between stress and health need to be understood in the context of the “stress response”, which has physiological, behavioural and psychological (encompassing affective or emotional, and cognitive) dimensions (see Figure 3.9).

![Figure 3.9. Dimensions of the ‘Stress Response’ (After Cox 1978, p.19 material reproduced with permission)](image_url)

In the present study, affective aspects of stress were measured by the Stress Arousal Checklist (SACL) (Cox, 1990;1992; Cox & Griffiths, 1995; Gotts and Cox, 1990). The SACL assesses two constructs: stress, relating to feelings of unpleasantness-pleasantness (hedonic tone), and arousal - relating to feelings of vigour and wakefulness/drowsiness (Cox, Gotts and Mackay, 1988; Cox, 1990; 1992). It was not practicable to assess behavioral aspects of the stress...
response, *per se*, although some elements of cognitive behaviour were included within the scale termed ‘self-reported performance capacities and adequacy’ (SPPCA), and also within the Wornout scale, as noted above.

Physiological aspects of the stress response were measured in terms of levels of adrenaline, noradrenaline and cortisol. These ‘stress hormones’ provide indices of one part of a complex pattern of physiological activity associated with the experience of stress, which comprises a multi-phased, coordinated autonomic nervous system and neuroendocrine response (Biondi & Picardi, 1999; Henry, 1992; Frankenhaeuser & Johansson, 1986; Harbuz, 2003; Sluiter *et al*, 2000; Meijman *et al*, 1995; Pike *et al*, 1997). Various possible pathways linking different dimensions of the stress response and health outcomes have been identified.

An increased risk of musculoskeletal disorders has been associated with physiological aspects of the stress response, as outlined in the above section on physical discomfort, and stress hormone levels were identified as having a potential role in that injury process. Table 3.1 summarises recent research evidence that adrenocortical response may vary in terms of the individual’s reactivity to and recovery from stress (Cacioppo *et al*, 1998; Heim, Ehlert & Hellhammer, 2000; Sluiter *et al*, 2000a, 2000b, Myrtek, 1995). This table shows hypothesised relationships between a range of physical and psychological states and Adrenaline (A), Noradrenaline (NA) and Cortisol (C), for which there are varying levels of empirical evidence.

As shown in Table 3.1 some authors have proposed, or empirically demonstrated, linkages between individual states or moods and specific hormone levels, although Frankenhaeuser (1991) was sceptical about the specificity of such linkages. She contended that both adrenaline and noradrenaline are released under the same situations, and that adrenaline is a general non-specific indicator of *mental* arousal that increases regardless of whether the related affective state is positive or negative, reflecting the *intensity* of the experience rather than that of any easily identifiable mood. She further argued that noradrenaline is a non-specific indicator of *physical* arousal, its levels increasing as a result of physical exertion, and that cortisol release is associated with increases in negative affective states (Frankenhaeuser, 1991).
Table 3.1. Hypothesised Relationships between Individual States and Endocrine Correlates

<table>
<thead>
<tr>
<th>Physical or Psychological States</th>
<th>Adrenocortical Hormones</th>
</tr>
</thead>
<tbody>
<tr>
<td>physical activity</td>
<td>NA ↑</td>
</tr>
<tr>
<td>locomotion</td>
<td>NA↑ &gt; A↑</td>
</tr>
<tr>
<td>mental activity/engagement</td>
<td>NA↑ &gt; A↑⁹</td>
</tr>
<tr>
<td>pleasure/challenge</td>
<td>A↑ &gt; NA↑</td>
</tr>
<tr>
<td>anticipation</td>
<td>A↑ NA↑ C↑</td>
</tr>
<tr>
<td>uncertainty</td>
<td>NA↑ A↑</td>
</tr>
<tr>
<td>effort, tenseness or concentration</td>
<td>High A↑ Low NA↑ Low C↑</td>
</tr>
<tr>
<td>boredom or tiredness</td>
<td>Low A↑ High NA↓ Moderate C↑</td>
</tr>
<tr>
<td>anxiety/distress/grief</td>
<td>C↑ &gt; NA↑ A↑</td>
</tr>
<tr>
<td>anger</td>
<td>NA↑ &gt; A↑</td>
</tr>
<tr>
<td>hopelessness/depression</td>
<td>C↑ A↑</td>
</tr>
<tr>
<td>effective coping</td>
<td>C↓ Reduced hormonal reactivity</td>
</tr>
<tr>
<td>activity and negative affect</td>
<td>A↑ C↑</td>
</tr>
<tr>
<td>activity and positive affect</td>
<td>A↑ C↓</td>
</tr>
<tr>
<td>passivity and negative affect</td>
<td>A↑ C↑</td>
</tr>
<tr>
<td>passivity and positive affect</td>
<td>Slight ↓A Slight C↓</td>
</tr>
</tbody>
</table>


Based on extensive investigations of relationships between work environment factors, mood and adrenocortical hormone levels, Frankenhaeuser and her colleagues (Frankenhaeuser, 1981, 1986, 1989, 1991; Frankenhaeuser & Johansson, 1986; Frankenhaeuser et al, 1989) conceptualised the kind of relationships depicted in Table 3.1 in terms of an ‘activity-affect model’. This model was the primary basis for selection of adrenaline, noradrenaline (catecholamines), and cortisol as the stress hormones to be measured in this project. According to this model:

- Catecholamines (adrenaline and noradrenaline) and cortisol levels will be lower when people are physically and mentally passive and are experiencing positive affect;

⁹ Although large individual variations are reported Biondi & Picardi, 1999.
• Cortisol levels will be higher when people are physically and mentally passive and are experiencing negative affect;

• Both catecholamines and cortisol levels will be higher when people are physically and mentally active and are experiencing negative affect; and

• Catecholamines levels will be higher but cortisol lower when people are physically and mentally active and are experiencing positive affect (Frankenhauser, 1991).

JOB SATISFACTION

Within the framework of the JobLoad Model, job satisfaction (and dissatisfaction) is of interest because of its likely implications both for people’s motivation to exert effort, and for the more general nature of their work behaviours as they affect performance adequacy. Also, job dissatisfaction can lead to disengagement (as opposed to organisational commitment), higher turnover rates, and non-legitimate absenteeism (Baker et al., 1996; Tetrick, 1992; Sauter, Murphy & Hurrell, 1992).

As outlined earlier in this chapter, satisfaction entails cognitive judgments about the perceived adequacy or satisfactoriness of the job and its various aspects. Fraser (1983) wrote that a positive state of job satisfaction exists when, on balance, "...the perceived benefits of the work exceed the perceived costs by a margin deemed by the worker to be adequate under the circumstances" (Fraser, 1983, p.24).

Consistent with this view, the Effort-Reward Imbalance model (Seigrist, 1996, 2003) (see Figure 3.8 above) proposes that job satisfaction requires a suitable reciprocity between ‘rewards’ and the ‘effort’ expended. The nature of satisfying ‘rewards’ will vary for each individual depending upon their needs, attitudes and expectations (Rhoades & Eisenberger, 2002; Siegrist, 1996; Ferrie et al., 1995). Some rewards are ‘extrinsic’ in nature, such as salary and related benefits, job security, and career development opportunities. Others are essentially ‘intrinsic’ in that they contribute to people’s inner wellbeing by enhancing their self-esteem and feelings of self-efficacy, for example by conferring status and prestige, or by being enjoyable and/or satisfying (Siegrist, 1996; Siegrist et al., 1997). For most people, good relationships with co-workers satisfy a range of important emotional and social needs and thus contribute to intrinsic job satisfaction (Bongers et al., 1993; Klitzman and Stellman, 1989; Undén 1996). Related to the distinction between extrinsic and intrinsic forms of reward, Hertzberg’s (1966) two-factor theory of job
satisfaction represented evidence that the factors most strongly predictive of positive satisfaction are different from those that most strongly predict dissatisfaction; accordingly, job characteristics can be subdivided into ‘motivator’ and ‘hygiene’ factors. In practice, good job design needs to address both types of factor (McCormick et al, 1992; Spector, 1985), and to provide both extrinsic and intrinsic rewards.

There is some debate concerning the extent to which individual variables (e.g. personality; cognitive processes) influence satisfaction, relative to the influence of job-related variables such as those noted above (Cass, Siu, Faragher & Cooper, 2003). Both types of variable have been shown to be important when measured concurrently. For example, an individual’s level of commitment to coping successfully with a high workload is likely to be enhanced both by support and encouragement from colleagues and management, and by personal beliefs and attitudes consistent with a high level of performance. According to Colarelli, Dean and Konstans (1987), job-related variables tend to account for more variance in satisfaction than do personal factors. Kulik, Oldham and Hackman (1987) reported that situational and personal factors may interact in their effects. It is certainly true that when job design has a good ‘fit’ with an individual’s particular skills and abilities, needs and desires, the job is likely to be experienced as more satisfying (Brief and Weiss 2002; McCormick et al, 1992; Spector, 1985). However, some work and job characteristics tend to be generally satisfying for most individuals.

The Job Characteristics Model formulated by Hackman and Oldman (1976, 1980) is one of the most well founded and widely utilised theories supporting the measurement of job satisfaction (Fried & Ferris, 1987). According to this model, there are five "core" job dimensions that influence employee motivation and job satisfaction. These are skill variety, task identity, task significance, autonomy and feedback. High levels of these factors are expected to result in high levels of three “critical psychological states” that are seen as intervening between job characteristics and individual satisfaction and wellbeing. These psychological states are: experienced meaningfulness of the work, experienced responsibility for outcomes of the work, and knowledge of the actual results of the work activities.

Kuk, Kivimaki and Elovainio (1997) argued that the Job Characteristics Model primarily addresses the job factors relevant to satisfaction among people performing fairly simple, repetitive work. They suggest that when work performance is more complex and requires coordination with others, the nature and quality of team co-operation will also be important influences on job satisfaction.
Based on the Job Characteristics Model, supplemented by more recent research evidence as reviewed above (also: Kasl, 1992; McCormick & Ilgen, 1987; Spector, 1985; Oshagebemi, 1999; Sousa-Poza & Sousa-Poza, 2000; Wanous, Reichers & Hudy, 1997), the following job characteristics have been found to be most consistently related to job (dis)satisfaction:

- skill variety, opportunities to use and develop new skills and the work is sufficiently challenging (e.g. Warr, 2002)
- task identity and responsibility for a whole unit of work (e.g. Fried & Ferris, 1987)
- tasks are perceived as meaningful and significant (e.g. Fried, 1991)
- appropriate levels of job control and autonomy (e.g. Spector and O’Connell, 1994)
- there is clear information about what needs to be done and performance standards and feedback on performance (e.g. Rizzo, House & Lirtzman, 1970)
- satisfactory interpersonal relationships (e.g. Warr, 2002)
- satisfactory support from others (e.g. Baker, Israel & Schuman, 1996; Cummins, 1990)
- management is seen as equitable and just (e.g. Cotton & Hart, 2003; Siegrist et al., 1997)
- rewards are fair (e.g. Siegrist, 1996; Siegrist et al., 1997), and in line with aspirations (Allen & Griffith, 2001).

SELF-PERCEIVED PERFORMANCE CAPACITIES AND ADEQUACY

According to the JobLoad Model, the adequacy of performance – both objectively, and self-perceived – is in part a function of the ‘goodness of fit’ between Work Demands and Coping Capacity, influenced also by aspects of Job Control and Variety. In this project, participants rated the adequacy of their overall work performance and the quality of their work-related decision making, problem solving, concentration and creative and clear thinking. They also rated their own, overall performance quality. These ratings were combined to form a score for Self-Perceived Capacity and Adequacy (SPPCA). These items assessed cognitive but not physical capacities, consistent with the work of people within this study.

SPPCA has some conceptual overlap with the Personal Accomplishment scale of the Maslach Burnout Inventory (Maslach & Jackson, 1986). However the latter scale is specific to emotional work (Adelmann, 1995; Briner, 1999; Totterdell & Holman, 2003) and also encompasses perceived outcomes of performance, whereas SPPCA focuses on cognitive work and includes an evaluation of performance itself rather than subsequent outcomes. SPPCA also differs from self-efficacy, which is generally conceived as a trait rather than a state (Bandura, 1977). It would be...
expected that traits such as self-efficacy would influence SPPCA, but in the present project focus was on determining: (a) the main work and job characteristics influencing SPPCA (controlling for some individual variables); and (b) relationships between SPPCA and the measured dimensions of wellbeing.

Depending on the quantity and quality of available performance feedback, SPPCA is likely to be significantly correlated with objective performance. However, interpretation of such correlations may be complicated by the fact that the validity of ‘objective’ data on performance quality is likely to be questionable in jobs where it is possible for this to be defined in terms of a wide variety of criteria, because in such circumstances different individuals are likely to define their own performance goals in a wide variety of ways, possibly entailing differing ‘trade-offs’ between performance quantity or output, and performance quality – however defined. In any case, it is SPPCA rather than actual performance that is seen here as the key variable intervening between work/job characteristics and individual wellbeing.

Choice of performance strategy in the presence of increasing work demands may influence wellbeing as well as performance itself. Someone might choose to exert more effort in an attempt to continue coping and to overcome any associated impediments or they might choose to maintain effort at a steady state, accepting a decline in performance. The former strategy will have a behavioural and physiological cost but so too may the latter, as poorer performance might increase anxiety associated with perceived threats to employment security (Hockey, 1997; Jex, 1998).

There might be a variety of ways in which performance could be maintained at high levels of work demand. If workers have sufficient control they may also be able to shed some subtasks in order to protect the performance of core tasks. Sometimes, however, such strategies might not be available, and if absolute capacity is reached and demands continue to increase, performance will decline, irrespective of motivation level (Hart & Staveland, 1988; Kahneman, 1973; Kantowitz, 1987; Jex, 1988). Whether or not SPPCA will also decline is less easily predictable. It could be that when work demands are generally acknowledged to be excessive such that performance inevitably suffers, individuals may nevertheless feel that they are coping well in the circumstances – in which case there might be no deterioration in SPPCA. Whether or not individual wellbeing would be protected from deterioration in such a case is unclear, but there is evidence that employees with heavier workloads who feel that they are accomplishing a lot, and
who are experiencing an associated sense of heightened satisfaction, may rate their own performance as higher (Beehr et al., 1997; Spector, 1988).

In situations where boredom is a problem, it might be that higher work demands may help to create a sense of challenge and enhance motivation, with consequent increases in arousal, coping capacity, resultant performance, (Jex, 1988) and perhaps SPPCA. An inverted curvilinear relationship between arousal and performance is well-documented (Broadbent, 1971; Jex, 1988), although the effect of arousal level on performance varies with the nature and difficulty of the work (Kahneman, 1973, p.35). For cognitively complex work (such as that performed by participants in this study), very high levels of arousal are likely to result in difficulty in concentrating and allocating attention optimally between different components of work (e.g. Proctor & Van Zandt, 1994).

As someone becomes increasingly fatigued so that their performance capacity is reducing, they will need to invest increasingly greater amounts of effort to maintain their performance, and at some point their performance to likely to deteriorate, possibly with a consequent increase in stress and performance errors (Hockey, 1997). If there is a significant level of physical fatigue, any associated discomfort or pain may divert attentional and emotional resources to cope with this experience. While the motivated individual may choose to continue to work despite discomfort, eventually pain might decrease the individual’s ‘willingness to spend’ effort. Increased stress has also been identified as likely to reduce motivation to expend effort (de Jonge et al., 2000; Jex, 1998; Siegrist, Klein, & Voigt, 1997).

There is some evidence that when people perceive that their performance is deteriorating, this in itself can function as a stressor that in some situations may lead to ‘burnout’ – even although performance quality is still within officially acceptable standards. Burnout does not necessarily lead to deterioration of actual performance (see Schaufeli & Enzmann, 1998), and among intensive care nurses, a positive relationship has been found between burnout and performance (Keijsers, Schaufeli, Le Blanc, Zwerts, & Reis Miranda, 1995). It may be that these nurses overworked themselves in order to achieve a high level of performance (i.e., high performance standards may have served as a precursor of burnout). In some other studies, however, burnout was inversely related to performance. In a prospective study of human service professionals (Wright & Bonett, 1997), burnout appeared to predict deteriorating performance. In addition, burnout has been associated with late arrival and longer than normal work breaks, as well as
more errors and personal injuries (Kahill, 1988), and with a diminished capacity for creative problem solving and proactive behavior (Noworol, Zarczynski, Fafrowicz, & Marek, 1993).

It is easy to assume that satisfied and happy employees will perform better than dissatisfied ones, but evidence concerning relationships between job satisfaction and performance is somewhat equivocal (Helander, 1997). Even when employees are dissatisfied, under conditions where their performance is closely measured and failure to perform would have serious consequences for pay or job security, performance may be maintained. Nevertheless, Schott (1992) argued that while dissatisfied workers can be ‘seen’ to be productive and may even maintain production levels, if dissatisfied they are not likely to be working to their full productive capacity and it is doubtful whether they will be fully committed to the organization’s mission. Consistent with this, Hart and Cotton (2003) have reported that low morale (at an individual level) is predictive of poorer ‘discretionary’ performance – that is, people whose morale is low will less often perform helpful activities that are not part of their core job requirements. Also, dissatisfied employees are more likely to engage in antagonistic work behaviours (Duffy, Ganster & Shaw, 1998). On the other hand, there is some evidence that satisfied workers will be more tolerant of difficulties and even of bodily discomfort (Andersson et al, 1983; Ivancevich & Matteson, 1999; Keyserling, 2000). Seigrist (1996) argued that the relationship between performance and job satisfaction is moderated by whether or not the rewards resulting from effort are viewed as equitable. If they are, satisfaction will increase and employees will be motivated to sustain effort.

Considering the potential effect of perceived performance adequacy on affective state or job satisfaction, Weis et al (1999) observed that most people would rather do something well than poorly, so self-perceived good performance is likely to enhance both mood and Job Satisfaction. Noting this, Judge et al (2001, p.392) commented that "……. although there is a great deal of research on the effects of mood on performance, it surprises us that research on the effects of performance on mood is lacking.” This is an issue addressed in the current research – at least for self-perceived performance.

Based on a meta-analysis, Judge et al. (2001) concluded that the correlation coefficient for the relationship between satisfaction and performance is usually around 0.3, with values tending to be higher for more complex jobs in which people have greater autonomy.
SUMMARY

Work-related wellbeing of individual workers has been depicted here as a multidimensional condition that is characterised by low fatigue, low bodily discomfort, moderate to moderately high arousal (depending on the nature of the work), low stress, and high work-related satisfaction (Baker et al, 1996; Cox, 1990; Gotts and Cox, 1988; Karasek, 1979; Seigrist, 1986, and Warr, 1997). Different aspects of wellbeing in this multidimensional sense are conceptually interrelated (to varying degrees) and have many precursors in common. Empirically also, they are often correlated.

As has been discussed in this chapter, there are a range of well accepted conceptual models and associated measurement methods related to various aspects of work-related wellbeing – especially stress and satisfaction. It was beyond the scope of this thesis to critically and comprehensively review the large research literatures concerning these models, since the present focus is on workload rather than on stress, satisfaction or wellbeing more generally. However, this chapter has demonstrated the availability of adequate concepts and measures of various aspects of wellbeing, and has described the specific constructs measured in this study.

Each of the later chapters that present and discuss results of this study, do so separately for different aspects of wellbeing. That is, empirical evidence of relationships between wellbeing and the factors depicted by the JobLoad Model as influencing wellbeing, are presented separately for different wellbeing components. In the penultimate chapter, similarities and differences between different aspects of wellbeing in terms of their work-related predictors are summarised and discussed, and in the final chapter, results are reviewed separately for each of the factors investigated as potential predictors of wellbeing, prior to a final discussion of all findings.
PART 2: DEVELOPMENT OF MEASUREMENT INSTRUMENT

Measurement Requirements

Study Design and Data Collection Procedures

Data Preparation and Development of the JobLoad Index
Chapter 4

MEASUREMENT REQUIREMENTS AND AVAILABLE MEASURES

INTRODUCTION

The methods section is presented over four chapters. This Chapter (Chapter 4) describes the measurement requirements for achievement of the study aims, which were:

1. to formulate a conceptual JobLoad Model, to provide a more detailed and comprehensive account of the main factors which contribute to the workload of a whole job;

2. to develop a questionnaire for use in measuring each of the constructs within the JobLoad Model (collectively termed the Job Load Index – JLI), based on a review of existing questionnaires and the development of new items as necessary;

3. using the JLI, to determine relationships between a range of task, job, and environmental factors as identified by the JobLoad Model, and the following aspects of wellbeing:
   VI. ‘Self-perceived performance capacity and adequacy’ (SPPCA)
   VII. psychological and physical fatigue (using a ‘Wornout’ scale, and ratings of ‘Bodily Discomfort’)
   VIII. subjective ‘Stress’, and levels of ‘stress’ hormones (Adrenaline, Noradrenaline and Cortisol)
   IX. subjective ‘Arousal’
   X. ‘job satisfaction’.

In this chapter, available measurement methods are reviewed in relation to detailed measurement requirements, as identified by the key determinants of workload, individual wellbeing, and self-perceived performance as described in Chapter 2 and 3 and summarised in the JobLoad Model (Figure 2.2). Chapter 5 then describes the study design and data collection procedures, and Chapters 6 and 7 describe data preparation procedures and development of the JobLoad Index constructs.

The literature search has revealed that no single existing measurement tool is able to provide all the information needed for this study, which crosses multiple disciplinary boundaries. What
follows is a synopsis of potentially useful instruments from the domains of ergonomics, human factors psychology, organisational, industrial and occupational health psychology.

Of primary importance was information about people’s workload. This concept of workload is drawn primarily from the literature of cognitive psychology and human factors, and physical workload from the human factors psychology and human physiology arenas. Human factors methods for measuring ‘workload’ are categorised as: (1) primary task performance measures (2) secondary task performance methods, (3) subjective rating methods, and (4) psychophysiological methods.

**Primary Task Performance Measures**

These measures provide detailed information about actual work task performance. However, they are usually highly intrusive, do not provide diagnostic information and, most importantly, are insensitive to differences in workload when task demands do not exceed the individual’s performance capacity (Meshkati, Hancock & Rahimi, 1990; Tsang & Wilson, 1997). Therefore, this type of measure was considered unsuitable for use in the present project.

**Secondary Task Performance Measures**

These measures assess workload level by quantifying the subject’s available spare attentional capacity. Subjects are asked to perform the primary task that is of interest while also performing a secondary task, with the proviso that primary task performance must not be allowed to deteriorate. The difference in secondary task performance when that task is performed alone, compared with when it is performed concurrently with the primary task, is taken as an indication of primary task workload. While this method can be quite sensitive, the addition of a secondary task is often intrusive and results can be complex to interpret (Macdonald, 2003; Meshkati, Hancock and Rahimi, 1990; Tsang and Wilson, 1997). Therefore, this type of measure was considered unsuitable for use in the present project.

**Subjective Rating Measures**

Subjective rating measures provide an estimate of the workload level by those actually experiencing it, either during or immediately after the task of interest has been completed. Such measures have been validated in a wide range of conditions. They are regarded as generally acceptable to users, and able to sensitively discriminate any significant variations in mental workload, and have excellent face validity as they depend directly on the subjects’ actual experience of the workload. They have the strong advantage within real work environments, that
they do not significantly disrupt task performance and are relatively easy and inexpensive to administer. A criticism of this measurement approach is that those aspects of workload that are not consciously accessible are likely to be under-estimated (Tsang and Wilson, 1997; Wierwille & Eggemeier, 1993; Vidulich, 1988).

Over recent decades two of the most widely used and accepted of subjective rating measures have been the Subjective Workload Assessment Technique (SWAT) (Reid, Potter & Bressler, 1989) and the NASA-Task Load Index (Hart and Staveland, 1988) (Gopher, 1984; Hancock & Desmond, 2001; Tsang and Wilson, 1997).

The **Subjective Workload Assessment Technique** (SWAT) was originally developed to assess pilot workload. It is based on a multidimensional model of workload, according to which subjects rate their workload as one of three levels (low, medium, and high) on each of three dimensions: mental effort load, time load, and psychological stress load (Reid, Potter & Bressler, 1989). The ‘time load’ dimension is comparable to the JobLoad Model’s ‘temporal demands’, the ‘mental effort load’ to the combined impact of the JLM ‘cognitive demands’ and ‘demand for care and vigilance’, and the ‘psychological stress load’ to the JLM ‘stress’ dimension.

The **NASA Task Load Index (TLX)** is another multi-dimensional rating procedure which provides an overall workload score based on a weighted average of ratings on six subscales: Mental Difficulty, Physical Difficulty, Time, Effort (mental and physical), Own Performance (how poor to good), and Frustration/ Stress (Hart and Staveland, 1988). The NASA-TLX has several clear advantages as a field workload tool. It has high face validity and operator acceptance, can be used diagnostically (by providing indications of where actual sources of workload may be excessive).

Studies such as those of Hart and Staveland (1988) and Hill et al. (1992) have shown that the NASA-TLX is superior to SWAT in terms of sensitivity, especially for low mental workloads (Nygren, 1991). It has very high levels of operator acceptance (when rated against the Modified Cooper Harper [Rahimi & Wierwille, 1982] and Overall Workload Scale [Hill et al., 1992] [Gopher, 1984; Hendy et al. 1993; Weirwille & Eggemeier, 1993]). While the TLX scales were intended as an indicator of *task* workload, they have clear applicability to the measurement of job workload. The last item in the TLX asks for ratings of ‘frustration’, indicating potential relevance to workplace stress (Hart & Staveland, 1988).
Despite its strengths as a measure of task workload, Macdonald (2004; 2003) reported that as a measure of job workload the TLX has been found inadequate. She considered that a broader-based more comprehensive set of measures is required to cover all the task, job, and organisational factors which contribute to job workload. The task of creating such a set of measures has been undertaken as part of the present project.

As a result of these observations Macdonald and co-workers have trialled and developed some modifications to the TLX workload scales to fit them better for use in various Australian workplaces and for measurement of the whole job (see O’Bryan et al., 1991; Upsdell, 1994; Macdonald & Upsdell, 1996; Macdonald, 2004; Macdonald, 2003; Macdonald, 2001). From this basis, items for use in the present study were developed to encompass the constructs listed below.

- **Mental Demands**
  - Cognitive Demands. e.g. items ‘complex decision-making’, ‘need remember different things’, ‘rapid decision-making’; and
  - Demand for Care Vigilance. e.g. items ‘careful looking or listening’, ‘monotonous/boring work’, ‘need to working carefully to get things right’, ‘very repetitive work’.

- **Physical Demands**
  - Static Physical Demands e.g. items ‘precise accurate movements’, ‘awkward body or arm positions’, ‘long periods sitting/standing’; and
  - Dynamic Physical Demands e.g. items ‘strenuous/forceful actions’, ‘walk fast’ and ‘risk of injury’.

- **Emotional Demands.** e.g. items ‘dealt with people hurt or upset’, ‘or aggressive or unpleasant’, ‘need to hide feelings from others’, ‘need to listen sympathetically to others’, and ‘errors had important consequences’,

- **Temporal Demands**
  - Time Pressure. e.g. items ‘deadlines’, ‘excessive time pressure’, ‘urgent tasks’, ‘work fast’, ‘conflicting demands on your time’;
  - Too Much to Do In Available Time, e.g. items ‘excessive workload’, ‘workdays hectic’, ‘not time to take it easy’, ‘not time to work in a relaxed way’, ‘not enough time’, ‘not able do non-urgent tasks’, ‘not let mind wander’, ‘backlog of work’

- **Effort** e.g. items ‘big effort’, ‘work hard’, ‘lots of concentration’.

- **Own Performance** e.g. items ability to make decision, problem solve, think clearly, concentrate, rating of overall performance
Rather than simply use the **Frustration** scale, instruments specifically developed for the assessment of occupational stress were reviewed. Workloads that are too high or too low are likely to provoke affective responses (stress, frustration, anxiety dissatisfaction and so on). Items related to these states are noted in the sections on stress, arousal, fatigue/wornout and work-related satisfaction later in this chapter.

**Psychophysiological Measures**

Psychophysiological measures are objective metrics that focus specifically on human physiological (and sometimes biochemical) responses to situations. They are used both prior to and during activity to appraise the task loads, and/or subject’s ability to carry out the required tasks in the required time. A variety of psychophysiological metrics can be taken to measure the effects of demanding situations including:

- Central Nervous System measures (such as electroencephalographic activity, event-related brain potentials, magnetoencephalographic activity, positron emission tomography to determine brain metabolism, and electro-oculographic activity) and
- Peripheral Nervous System measures (such as cardiovascular measures [blood pressure, respiratory rates, and heart rate and variability] electrodermal activity, critical flicker fusion, immune status and levels of stress hormones -catecholamines and cortisol (Frankenhaeuser, 1991; Gopher, 1984; Kramer, 1991; Tsang & Wilson, 1997).

Psychophysiological measures are reasonably popular methods for exploring the impact of mental workload and motor demands in laboratory settings. These measures are inherently multidimensional and can theoretically provide a number of 'views' of the subject’s response to mental workload. Some of the measures (for example ambulatory heart rate or blood pressure) allow a continuous objective record of the physiological response over an entire workday and if accompanied by work analysis the identification of local variations (to workload demands) and their causes (Kramer, 1991). However, they are often highly intrusive (for example requiring wearing transducers or the collection of bodily fluids), and results are difficult to analyse and interpret.

Finally a serious and ongoing limitation is that there is still no general agreement of which psychophysiological results are the most sensitive and accurate indices of fatigue or mental workload (Frankenhaeuser, 1991; Gevins *et al.*, 1995; Gopher, 1984; Kramer, 1991; Tsang & Wilson, 1997).
Numerous authors have examined the impact of task, job and environmental demands on the individual’s mood and levels of urinary, salivary or venous stress hormones (Boucsein et al., 1996; Dunn, 1995; Fibiger et al., 1986; Frankenhaeuser, 1991; Gilberg et al., 1986; Goldstein, 1995; Kirschbaum et al., 1989; Lundberg et al., 1990; and others).

While some authors (see Cummins & Gevirtz, 1993; Henry, 1992; and others) propose that different mood states will have different neurohormonal correlates, Frankenhaeuser (1991) is sceptical about the ability to be so highly specific. Rather she proposes that both adrenaline and noradrenaline are released in the same situations. However, adrenaline can be taken as a general non-specific indicator of mental arousal increasing regardless of whether the affect is positive or negative and will tend to reflect the intensity of the experience rather than that of an easily identifiable mood. She proposed that noradrenaline is a general non-specific indicator of physical arousal where levels of this hormone increase because of physical exertion. Finally, she sees cortisol as being more clearly associated with increases in negative affective states (Frankenhaeuser, 1991). The personality traits and coping styles, although hypothesized to influence individual stress levels, were not determined in this study as the specific neuroendocrine responses to stress attributed to them have not yet yielded conclusive results (Bossert et al., 1988).

Frankenhaeuser’s (1991) ‘activity-affect model’ (discussed in chapter 3) was used as the underpinning psychophysiological model for considering the effects of work demands on stress hormones in this study.

**TASK AND JOB DEMANDS MEASURES FROM STRESS/HEALTH PSYCHOLOGY**

Many task and job demands measures are drawn from the stress and health psychology literatures. Analysis of the content of ‘job demand’ scales used in stress-related questionnaires shows that the most commonly occurring constructs are quantitative demands, qualitative demands, and time pressures. Human factors psychology measures of ‘workload’ provide some information about the psychological state that is a consequence of coping with ‘work’ demands, and also some rudimentary data about task demand levels (physical demand, mental demand, and temporal demand).

In the context of job workload, however, there is often a need for more detailed information about the nature of concurrent task and job demands, to provide a meaningful context for
information about employees’ psychological state and as a basis for developing interventions to improve system functioning. Macdonald (2003) argues that standard NASA-TLX scales fail to address some types of job demand, which would be expected to influence people’s experience of workload, which is related to their overall job performance. She urges that human factors workload measures should be broadened to encompass not just the task demands, but also those arising from the job and organisation. Further, the affective state arising e.g. different types of ‘stress’ and ‘satisfaction’ – should be clearly delineated from measures of workload (despite stress being included within some definitions of workload) where the primary purpose of workload assessment concerns employee health and wellbeing, rather than the evaluation of equipment or work systems (Macdonald, 2003).

**Quantitative Demands**

Information about quantitative demands are commonly collected but are often used quite narrowly to refer to the number of hours worked, shift duration and sometimes the time on a particular task.

However in the jobload model, these demands are viewed more broadly and include other factors which will contribute to the total hours worked. This may be the demands associated with being ‘on call’ for work at times other than normal working hours, travelling away from home to carry out work tasks, or more generally the need to work at awkward or unpleasant times that are not conducive to achieving home-work life balance (Heiler, 2001).

**Time Pressure**

‘Time pressure’ is a central dimension of the TLX (Hart and Staveland, 1988). It is expressed variably in other measures as ‘time load’ in the SWAT, as ‘work pressure’ in the Work Environment Scale (Moos, 1981), as ‘little time to get things done’ and ‘need to work very fast’ in the Generic Job Stress Questionnaire (Hurrell & McLaney, 1988), and ‘meeting deadlines’ in the Job Stress Survey (Speilberger & Vagg, 1998). Members of the focus group (See Chapter 5) had also reported that the lack of time to plan and think creatively about their work, was frustrating as it made the job more difficult to do well. Items related to time pressure and the overlapping concept of having just ‘too much to do in the available time’ were created; these are listed in the earlier section on demands.
Qualitative Demands

‘Qualitative demand’ usually refers to a state of overload (or underload) resulting from too many (or too few) functions, many responsibilities and a sense of uncertainty about the job. Variations in workload can have either negative or positive benefits (see earlier discussion) and four items were created in the composite measure JobLoad Index used in this study to reflect the type of workload variation experienced by subjects. These items were based on the work of Caplan et al., (1975) Hackman and Oldham (1975) and Rizzo et al., (1970) and included ratings on how much the: ‘workload varies from week to week’, ‘concentration varied from week to week’, ‘difficulty and complexity of work varied’, and the ‘required work rate varied’.

*Responsibility* for people and things add to the role complexity and is common in the various job stress measures, for example in the Occupational Stress Inventory (Osipow & Spokane, 1987) or the Pressure Management Indictor (Williams & Cooper, 1998) and others. Items often ask about responsibility for others’ welfare, for budgets, or management duties.

Working in *uncomfortable, unpleasant or hazardous physical environments* (too hot, cold, noisy, or crowded etc) is acknowledged as increasing overall demand and is included in the measures of stress (see Occupational Stress Inventory [Osipow & Spokane, 1987]; Generic Job Stress Questionnaire (Hurrell & McLaney, 1988). However, the inclusion of physical environment items was unnecessary as these were assessed by the researcher (a professionally certified ergonomist) during the job analysis. However, subjects instead were asked for their ratings of the physical demands ratings, which were previously listed (see page 77).

*Role ambiguity* and *role conflict* that leads to uncertainty about (work) roles, priorities, performance standards or even just how to do the job are included on measures such as the Occupational Stress Inventory (Osipow & Spokane, 1987) and the Rizzo and House Measures of Role Conflict and Role Ambiguity (Rizzo, House & Lirtzman, 1970). Based on the above, items were developed relating to: job/role ambiguity e.g. items ‘uncertain about what to achieve’, ‘uncertain about performance standard’, ‘uncertain about priorities between conflicting work’, ‘uncertain how much, overall expected to get done’, ‘uncertain how to do the tasks required’, ‘trouble working out whether you're doing your job well or poorly’, ‘usually do not know if work satisfactory’ and the related ‘work not closely supervised’.
Job and Organisational Impediments and Constraints

A wide range of impediments and organisational constraints to performance (viewed as stressors) are included in measures such as the Organisational Constraints Scale (Peters & O’Connor, 1980) the Work Environment Scale (Moos, 1981) and the Generic Job Stress Questionnaire (Hurrell & McLaney, 1988). Items considered relevant for this study (based on the literature review and the JobLoad Model) were those that were likely to increase demands and as a result the likelihood of negative affective response and poorer performance.

One of the most serious impediments to performance is the lack of suitably trained and experienced staff. Where staffing levels are is inadequate, or staff have inadequate skills, people are likely to have to work harder and/or work longer hours. Faulty or inadequate equipment, unnecessary or inefficient work procedures (red tape) or the slowness of other people in providing the information needed to do the job, are all significant impediments to performance (Ivancevich & Matteson, 1984; Moos, 1981; Osipow & Spokane, 1987).

Workplace conflict (with team members, supervisors, senior managers or clients) were noted in the previous chapters to be a potent source of stress and an impediment or constraint to effective performance, which require increased effort to overcome (Dewe & O’Driscoll, 2001; Elovainio et al., 2002; Jex, 1998; Rahim, 1983; Spector & Jex, 1998; Macdonald, 2003). Items related to interpersonal conflict were drawn from the Interpersonal Conflict at Work Scale (Keenan & Newton, 1985).

Career uncertainty has been reported as a cause of stress, negative health effects and dissatisfaction (for example see Caplan et al., 1975; Ferrie et al., 1998; Heaney, et al., 1994.). A focus group at site one (see chapter 5) revealed that the restructuring and downsizing that had occurred immediately prior to the data collection had led to considerable distress and dissatisfaction. Several items specifically related to this issue, based on Caplan et al (1975), were included at the request of participants. For example ‘uncertain job skills will be of use/value five years from now’, ‘uncertain about whether you could get another job if you lost this one’, ‘uncertain about what your job responsibilities will be in six months time’, and ‘uncertain career prospects’.

Supports

Informational and affective support from colleagues, supervisors, senior managers and friends and family can act as an important source of or a moderator of job demands. Items were created based
on the Generic Job Stress Questionnaire (Hurrell & McLaney, 1988), the Job Diagnostic Survey relating to feedback (Hackman & Oldham, 1975) and the Job Content Questionnaire (Karasek et al., 1998).

**JOB CONTROL AND VARIETY**

The issue of job ‘control’ is fundamental to most models of job workload and work-related stress. Items relating to control usually include: decision latitude, skill utilization, and influence and task variety. Items for this purpose were adapted from the Job Content Questionnaire (Karasek et al., 1998) and the Generic Job Stress Questionnaire (Hurrell & McLaney, 1988). These were:

- **Decision Latitude** e.g. items—‘not freedom decide order to do things’, ‘not freedom to decide when to take breaks’, ‘not freedom decide starting/finishing times’ and ‘not allowed make decisions on own’.
- **Skill Utilization** e.g. –‘not high level of skill’, ‘not opportunity to learn new things’, ‘do not use skills and knowledge’ and ‘work not creative’.
- **Influence** e.g. – ‘little freedom to decide how do work’, ‘not a lot of say in what happens’, ‘opinions and concerns not taken seriously’ and ‘not opportunity develop own abilities’.
- **Task Variety** e.g. -‘not variety of different things to do’, ‘very repetitive work’, ‘monotonous or boring work’ and having very ‘little freedom decide work pace’.

**MEASURES OF JOB PERFORMANCE**

In the domains of both ergonomics and occupational stress (particularly transactional models) the perceived match between demands and the individual is considered. However, rarely do any of the measures of either stress or workload (with the exception of the TLX) include questions that ask subjects to rate their own performance capacity or how satisfied/dissatisfied they were with it (as compared to their view of others’ performance). The TLX has one such item. However, given the importance ascribed to the construct of self-perceived performance in the JobLoad Model it was viewed as highly desirable to have additional items related to this construct. So, evolving out of the TLX ratings and from discussions with focus group members, five items were created which asked subjects to rate (how ‘good’ or ‘poor’) was their own performance: their ‘ability to concentrate’, ‘focus thoughts’, ‘make decisions’, ‘problem solve’, and ‘overall work performance’. In addition, two items were created relating to subject’s their satisfaction with their own performance: ‘satisfied with skills and abilities’ and satisfied with own work performance’ (Muse, Harris & Field, 2003).
Personal and Non-Work Factors Affecting Coping Capacity

The interaction between job demands and coping capacity is a key tenet of the JobLoad Model. In most workplace studies, it is usual to gather some personal and demographic information about subjects in order to account for the impact of these factors. Information is usually collected on subject’s age, gender, job experience and sometimes the presence of stressors arising from home responsibilities and the presence of injuries or ill health (see for example Cooper et al., 1988; Hart & Staveland, 1988; Shaughnessy & Zexhmeister, 1997; Spielberger, 1994; Osipow & Spokane, 1987; and others).

While individual characteristics related to their appraisal and coping behaviour (Lazarus and Folkman, 1984); generalized control beliefs (Spector, 1987); locus of control (Rotter, 1966), perceived self-efficacy (Bandura, 1977; 1997); and personality type (Fisher, 1995; Rees and Cooper, 1992.; Lefcourt et al., 1985) are commonly measured by organisational psychology researchers, investigation of these individual variables was beyond the scope of the present study.

MEASURES OF WELLBEING

Researchers in all of the domains relevant to this study concur that mismatches between job and individual characteristics (however conceived) are likely to be reflected, to some degree, in poorer wellbeing ratings – for example, in higher levels of bodily discomfort, feeling wornout, stress, and lower arousal and satisfaction.

Measures of Bodily Discomfort

Subjective ratings of bodily discomfort are commonly used in human factors and epidemiological studies to determine the location (in the body) of discomfort, its prevalence and the incidence of musculoskeletal discomfort and sometimes injuries. These include for example the ‘Nordic Survey of Musculoskeletal Complaints’ (Kuorinka et al., 1987) and the ‘Body Map Discomfort Rating Method’ (Corlett, 1976; Corlett & Bishop, 1992). The rating method proposed by Corlett was chosen, as it was short, simple to administer, had excellent face validity and was able to suit the needs of this study with slight modifications (such as the inclusion of eye discomfort).

Measures of Work-Related Satisfaction

Measurements of factors which were thought to theoretically contribute to work-related satisfaction and which may moderate the experience of workload as described in the JobLoad Model were needed. Of interest were factors related to satisfaction with the job itself, with the organisation and/or the relative rewards for effort. Several measures, whilst not suitable in their
entirety, have items related to satisfaction, which were able to be modified for use in this study (Spielberger, 1994; Hurrell & McLaney, 1988).

**Measures of Stress**

There are many measures of stress available, for example the Job Stress Survey (Spielberger, 1994) the Occupational Stress Inventory (Osipow & Spokane, 1987), the Occupational Stress Indicator (Cooper, Sloan & Williams, 1988) the Generic Job Stress Questionnaire (NIOSH, 1998) and the Stress Arousal Check List (Gotts & Cox, 1988).

The Stress Arousal Checklist (SACL) is quick and easy to use in a field environment, is relatively non intrusive and has existing Australian normative data. It asks subjects to what extent 30 common mood-describing adjectives match their current state. It arose from a transactional approach to stress (reflecting the individual’s interaction with and adaptation to their environment), which sits well with the concept of workload depicted by the JobLoad Model. The underpinning model of the SACL is based on two constructs:

(a) stress - relating to feelings of unpleasantness-pleasantness or hedonic tone (stress), and

(b) arousal - relating to feelings of vigour and wakefulness/drowsiness.

It had a distinct advantage (for the purposes of this study) as it provides not only a well accepted measure of ‘stress’ but also of ‘arousal’ (which is very important in influencing performance quality); it was considered to be appropriate for use in this study without modification. It has high reliability coefficients for two scales: for arousal 0.82, and for stress 0.80 (Cox, 1992:637).

A criticism of workplace stress studies is that ‘stress’ is not a unidimensional construct and that some demands may be stressful but have negative health effects, while other demands may provide impetus for change and so result in positive outcome (e.g. striving to overcome workplace conflict through better communications) (Cavanaugh *et al.*, 2000). This limitation is addressed by the use of the SACL, which provides information on the subject’s positive (arousal) and negative (stress) psychological states.

**Wornout**

Measurement of work-related tiredness, fatigue and feelings of being wornout is of increasing interest in workplace research (Akerstedt & Folkard, 1997; Haworth *et al.*, 1988; Fletcher & Dawson, 1997; Sluiter *et al.*, 2003). Many studies relate to the transport and aviation industries, including measures of vigilance. These are usually into either performance-based, or entail
measuring ocular physiology (Dinges & Malliss, 1998; Charlton & Bass, 1999). The transport industry has developed vehicle-based performance technologies to detect aberrant driver behaviour (Haworth et al., 1988; Mabbott et al., 1999). Increasingly common are mathematical models used to predict alertness and performance at different work periods based on the interactions of sleep, circadian variations, time on task and related temporal antecedents of fatigue (Belenky et al., 1998; Dawson et al., 2001). Finally there are a number of scales that use self-reported somatic states such as ‘drowsiness’ related to ‘the need to recover’ such as the SF-36 Questionnaire used on the Danish Work Environment Cohort Study (Ware & Sherbourne, 1992) and the General Wellbeing Questionnaire (Cox, 1983).

It was decided that the state of being wornout derived from the twelve items of the ‘Wornout’ dimension of the General Wellbeing Questionnaire (GWBQ) International Version (Cox, 1983) would be used as it was quick to administer, reliable, non intrusive and validated.10

This scale is designed to measure suboptimal health using self-reported symptoms of general malaise with the Wornout scale defined by symptoms relating to tiredness, emotional lability, and cognitive confusion (Cox, 1990). Cox and Gotts (1988) observe that the Wornout score will be determined by a number of factors including the nature of the person, their tasks and work environment. An additional uni-dimensional item on ‘general fatigue’ was also created.

CONSTRUCTS TO BE INCLUDED IN THE JOBLOAD INDEX

As discussed above no single measurement instrument was available which provided information about all the constructs of interest. Table 4.1. displays the measurement instruments used in this study and their theoretical capacity to provide information on demands, workload, or wellbeing. Each instrument is colour coded to indicate:

(a) **Red**- an existing instrument where no modification was required;

(b) **Green** - items derived in whole or in part from existing measurement instrument which needed to be modified to suit the specific needs of this study ; and

(c) **Blue**- unique items created for the purposes of this study.

---

10 Subsequent to the decision to use the GWBQ and commencement of data collection, some alternative fatigue measures emerged (for example the Copenhagen Psychosocial Questionnaire (Kristensen, 2002a); Checklist Individual Strength [Vercoulen et al., 1999]; Energy and Fatigue subscale [World Health Organisation, 1998]; and the 10 item Fatigue Assessment Scale [Michielsen et al., 2002]. However, in the interests of consistency it was decided to continue to use the GWBQ wornout dimension.
<table>
<thead>
<tr>
<th>Factors of Interest</th>
<th>Organizational &amp; Contextual Information</th>
<th>General and Specific Demands</th>
<th>Support</th>
<th>Inform/Environmental Impediments</th>
<th>Work-related Dissatisfaction</th>
<th>Self Perceived Performance Adequacy</th>
<th>Individual and Non-work Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measures Used in this Study</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work Analysis</td>
<td>***</td>
<td>**</td>
<td>*</td>
<td>***</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Job type &amp; level</td>
<td>**</td>
<td>*</td>
<td></td>
<td></td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Demand, control and support items</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td></td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>SPPCA and related satisfaction items</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>GWBQ Wornout Scale</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SACL Arousal Scale</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td>**</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>SACL Stress Scale</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Bodily Discomfort</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urinary Stress Hormones</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

(Researcher’s assessment of measurement instrument’s capacity to assess different factors of interest: fair=*, good=**; and excellent = ***)

79
Below is the JobLoad Model, wherein the same colour coding was used as above and **Black** to indicate constructs which, while theoretically important to workload, were outside the scope of this study to measure.

![JobLoad Model Diagram]

**Figure 4.1.** Measurement Instrument the JobLoad Index’s Theoretical Capacity to Provide Information about constructs of interest

---

80
STUDY DESIGN & DATA COLLECTION PROCEDURES

This chapter describes the study design and data collection procedures. A composite set of measures for the purposes of this study, referred to as the JobLoad Index (JLI), was developed based on the JobLoad Model (JLM; Chapter 4). Wherever suitable existing validated measures were available these were used; however, frequently the wording of items needed to be modified to suit the study requirements. Where no measures were available, items were developed specifically for the purposes of this study.

SELECTION OF STUDY SITES & APPROVAL PROCESS

For recruitment of work sites into this study, the following characteristics were seen as desirable:

- expected variations in employee workloads over the study period due to normal variations in work demands and/or expected organizational changes;
- reasonable numbers of employees within distinct occupational groups and performing similar job functions to allow jobs with varying demands to be contrasted;
- reasonable numbers of employees at different job levels within the organization, to enable determination of the effect of job level on workload demands;
- subjects within a normal adult working age and fit for normal work duties; and
- organizations located in Canberra to facilitate data collection.

Approaches were made to three organizations that met the criteria to undertake the study, and two of these agreed to participate.

Subject Recruitment: Site one

At site one, semi-structured interviews were held with the team supervisors and two small focus groups with a mix of staff. In this process, information about the organization, work system, local job demands and relevance (to staff) of the JLI ‘constructs’ were explored.

Following feedback on the face validity of JobLoad Index items, there were some minor modifications of items and two additional questions were added. These related to the ‘rate and type of organisational change’ and ‘satisfaction with the performance appraisal processes’.

The JLI was then piloted with staff in various job types at La Trobe University, and with ten participants from site one. These same participants also piloted the urine collection procedures.
Again, following this process, there was some further minor modifications to the questionnaire and procedures.

Data was then collected during the period March to December 1999. Collections were scheduled at dates likely to correspond with expected variations in workload. While this was a largely successful strategy, for many work groups the ongoing organizational restructuring, downsizing and program ‘rollouts’ meant that some teams in fact experienced less variation in workloads than had been originally anticipated. The sampling days were always on a Thursday to minimise the effect on ratings of ‘winding down’ for the weekend. Participants were asked to complete the JLI close to, or at the end of, the workday. Volunteers were instructed both orally and in writing to place the completed questionnaire in the locked ‘responses’ box on the researcher’s desk. Volunteers working overseas were contacted via e-mail and letter and asked to post their responses back to the researcher’s home office in preaddressed envelopes. For the final survey round, an additional section was added to the workload questionnaire, which asked questions about aspects of the work that were unlikely to have changed over the study period (see once only section of JLI Appendix 5.1.).

A total of 124 valid responses were received from the available population of 200.

**Subject Recruitment: Site two**

Recruitment of a second site commenced after completion of data analysis for site one. Site two was a smaller Australian Government agency that had been identified as of interest, due to reportedly high workloads and massive recruitment (95%) of new staff due to the relocation of the office from another city.

Officers were primarily engaged in specialist clerical work entailing the development and application of policy. Participants were very concerned about maintaining their anonymity, so name, age or team were removed from that version of the JLI (Appendix 5.2). The data were collected from this site in early October and late November 2002, to correspond with a known busy and a predicted quieter period.

Fifty-five employees participated in one or more data collection rounds from a total available population of seventy-five permanent employees.

Samples were not random as all subjects were self-selected volunteers and so there was likely to be some sampling bias. It is possible that people who felt they were experiencing an unacceptable workload may have seen participating in the study as a way of anonymously telling
managers about their distress and so over-representing high workloads. Alternately, some individuals declined to volunteer, or withdrew from the study, or delayed their data collections to a later date, because they were ‘too busy’, raising the possibly under representation of high workloads.

**Study Design**

A quasi-experimental design was used as both study sites were real workplaces where it was not practicable to manipulate the independent variables of main interest. Based on initial consultations with managers within the two sites, it was expected that at least two, and possibly three, data collection points could be determined which corresponded with normally occurring periods of low, medium and high workload.

In reality, however, various unpredicted circumstances within both workplaces meant that the expected variations in workload levels between the agreed data collection dates were minimal, and highly variable between individuals. Data from three data collections at site one and two data collections from site two were therefore treated simply as repetitions within subjects.

This ‘repeated measures’ approach allowed subjects to act as their own controls, facilitating assessment of relationships between the independent and dependent variables (Aron & Aron, 1994; Shaughnessy & Zechmeitster, 1997). A potential weakness of a repeated measures study design is that of a ‘carry over effect’ (Shaughnessy & Zechmeitster, 1997). Any such effect was probably minimal for site one as the three data gathering points were distributed over an 11-month period with points separated by several months. However, there may have been some such effect at site two as the data collection periods there were only six weeks apart.

The triangulation approach to measurement within this design enhanced the study robustness. The first reference point was the Job Description, which objectively established the main job demands; the second was the subjective ratings of job demands, wellbeing ratings and non-work variables derived from the JLI (detailed below); and the third was the objective biochemical measures (levels of urinary adrenaline, noradrenaline and cortisol).

**PHASES OF THE STUDY**

Data collection was undertaken intermittently over several years, and in distinct stages as indicated in Figure 5.1. While data analysis had been completed separately for each site in the preparation of the thesis, the results from the two study sites were compared and contrasted.
Figure 5.1. Phases of the Workload Study

JOB DESCRIPTION

The Job Description allowed the objective verification of the job demands in each site. Information about the job roles and demands was gathered by:

- Reviewing publicly available documents such as ‘Strategic Plans’ and Annual Reports\(^\text{11}\);
- Conducting Ergonomic Workplace Assessments of the physical working environments (the researcher is a Certified Professional Ergonomist) which considered the; lighting and thermal conditions, workstation layouts, equipment and tools, and manual handling requirements.

\(^{11}\text{in of maintaining confidentiality these details have not been included}\)
• Conducting semi-structured interviews and focus groups with subsets of employees and supervisors to determine the;
  o Team role and usual tasks,
  o Psychosocial and physical environmental demands, and
  o Job and organizational factors which were likely to influence overall work demands.

**Job Type and Level**

All subject answered questions in the JLI relating to their job role (title and description of duties). Using information gathered in the Job Descriptions all subjects were classified as belonging to one of four Job Types. These were:

a. Clerical Officers;
b. Information Technology Officers;
c. Technical Officers; or
d. Communications and Help Desk Officers.

At site one, subjects were allocated to one of the following job levels:

- Job Level One (the most junior officers) or
- Job Level Two (middle level officers) or
- Job Level Three- Four (most senior officers) or
- Job Level Five (contractors where the job level was unknown).

Site two had a smaller sample size and, to ensure anonymity, subjects were grouped into three job levels:

- Job Level One/Two (the most junior clerical officers) or
- Job Level Three (middle level officers) or
- Job Level Four (most senior officers).

Related to job level is that of responsibility. Subjects were asked in the JLI for ratings of how much responsibility they had for ‘expensive equipment’, ‘staying within budgets’, ‘others welfare’, ‘monitoring others performance’ and ‘managing others performance’.

**Personal and Non-Work Variables Relevant to Coping Capacity**

Information was collected in the JLI that related to the individual’s general capacity to meet demands including:
• Gender (requested from both sites);
• Year of birth (due to confidentiality requests only obtained from site one);
• Highest education level (due to confidentiality requests only obtained from site one);
• Length of time at current level (both sites);
• Length of time at current job (both sites);
• Stressful problems with family or friends (both sites);
• Physical injuries (both sites);
• Significant conflict between work and home demands (both sites);
• Dependent children and ages (both sites); and
• Subject name used to match the JLI and urine samples (site one only).

Non-Work Factors Affecting Coping Capacity

Items in the JLI were used to collect information about some non-work factors that might influence coping capacity. Participants were asked to respond with a yes or no to if they had stressful problems with family or friends; physical injuries; and significant conflict between work and home demands; they were also asked to supply the number of any dependent children and their ages.

Task and Job Demands

Items in the JLI were used to seek ratings of the task and job demands, which were thought to contribute to the experience of workload. Questions were constructed to ensure there was a mix of positive and negatively worded items and that the grouping of the theoretical constructs were scattered throughout the questionnaire. The stem for questions ranged from - ‘how much’; ‘how often’; how good/poor’; ‘agree/disagree’; ‘satisfied/dissatisfied’ ; and ‘satisfactory/unsatisfactory’.

Quantitative Workload

This is one of the most commonly reported job demands and was measured in two different ways using data from the JLI (questionnaire) items. These were the:

• Working Hours calculated by the following formula: (total reported work hours per day – breaks time) multiplied by the number of days on duty.
• Total Working Hours Score - took into account the Total Working Hours and additional loads created from being ‘on call’ and associated with ‘travel away from home’ and any ‘unofficial’ hours of work. This included any time spent ‘working from home’ and on the
‘working on the weekends’ (not including weekend shift work) that was reported by the subjects. Total Working Hours Score was calculated using the following formula: 

\[(\text{total reported work hours per day} - \text{break time}) \times \text{number of days on duty} + \text{hours worked at home} + \text{hours of weekend work} + \text{times on call} + \text{travel away from home}.\] (One point was assigned per ‘on call’ period, and per day spent travelling). For senior staff the requirement to undertake after-hours and/or weekend work is often not acknowledged and usually not directly remunerated but still contributes to the experienced workload.

**Job and Organisational Factors including Control and Support**

Scores were derived from a seven-point rating scale for 135 task, job and, organisational factors items. Appendices 5:1-2 list the full questionnaire items used for each site.

**SPPCA**

A set of items related to self-perceived performance capacity and adequacy and related satisfaction were developed for this study. Using a seven-point rating scale (from extremely poor to extremely good) participants rated the following items related to their state in the current week:

- general state of health this week;
- ability to focus your thoughts and think clearly;
- ability to make decisions;
- ability to concentrate;
- ability to problem-solve and think creatively; and
- overall quality of work performance this week.

**Stress Arousal Checklist**

The subjects’ stress and arousal levels were derived from a four-point rating scale for items from the *Stress Arousal Checklist* (Gotts and Cox, 1988.) in the main section of the JLI for both sites. Items were scored using the long scoring method as outlined in the manual by Gotts and Cox (1988).
Wornout Scale of the GWBQ

Wornout levels were derived from a four point ratings scale for the twelve items of the ‘Wornout’ dimension (GWBQ) of the General Wellbeing Questionnaire - International Version (Cox, 1983) and score calculated using the method outlined by Cox (1983).

Bodily Discomfort

Levels of Body Part Discomfort were derived from a five-point ratings scale for items based on the method of Corlett (1995) in the main section of the JLI. Scores were calculated for ‘Upper Body Part Discomfort’ (site one -four items and for site two -five items) and ‘Lower Body Part Discomfort’ (both sites two items).

General States

Using two, seven-point rating scales (from extremely low to extremely high) participants rated items on their general levels of stress and of fatigue that week.

Work-related Satisfaction

Work-related satisfaction levels were derived from seven-point rating scales for items developed from components of the NIOSH Generic Job Stress Questionnaire (Hurrell & McLaney, 1988) and items developed for this study in the main section of the JobLoad Index relating to ‘Dissatisfaction with Reward last six months’ (four items); ‘Job Dissatisfaction’ (four items); and ‘Dissatisfaction with Organisation and Change’ (five items).

Urinary Stress Hormones

The relationship between urinary stress hormone levels gained in laboratory studies and those gathered in the naturalistic settings are reported to be high if appropriate rigour is used (Lundberg et al., 1990). Serum, saliva, and urine samples are all commonly assayed to determine hormone levels after stress. However, serum and salivary hormone levels reflect recent hormone production (within the last few seconds to minutes) whereas urine samples provide longer more stable indices of SNS activity as urinary metabolites are collected over several hours (Burch, 1984). As such the urinary hormone levels constitute an estimate of the SNS arousal over the period between the voids with the margin of error being about one hour or less (Guyton, 1991; Elfering et al., 2003).

Epidemiological studies tend to use both 24-hour and ‘spot sampling’; however, for this study ‘spot sampling’ was chosen in preference to 24-hour collection as it was seen to have greater
subject acceptability and had fewer practical problems associated with collection and storage of bio-hazardous samples within an office environment. The cost of ‘spot assaying’ all the urine voided over the sampling day proved prohibitive; therefore, to achieve a representative sample of the excretion rate of hormones over the day, four of the spot samples were assayed for levels of the urinary hormones (Marieb, 1998). Excretion rates were calculated from these ‘spot samples’ and the volumes of urine voided.

The collection, sampling and assaying of urine samples were developed in accordance with the recommendations of Bjørgaas et al. (1998), White et al (1995), Rivero-Marcotegui et al. (1995), Greenberg et al (1985), Jenner et al. (1987), and Davidson and Fitzpatrick (1985). The processing of urine samples by the researcher occurred under the supervision of Dr John Schuijers (PhD biochemistry) of La Trobe University.

A brief supplementary questionnaire was also completed by subjects to provide information on personal details related to the interpretation of data from urine samples. Procedures to collect samples are detailed at Appendix 5.4 and the assaying processes at Appendix 5.5-6. Multivariate analysis techniques were then used to explore the relationships between task and job demands, wellbeing states and estimated daily amount of urinary free adrenaline, noradrenaline and cortisol were explored.

GENERAL METHODOLOGICAL PROBLEMS

The sample size of 124 subjects (294 data sets) from site one plus 55 subjects (88 data sets) from site two severely limited the researcher’s capacity to include in the multivariate analyses all of the variables which were likely to explain variance in wellbeing measures. The limited number of cases also meant that it was not possible to include interaction effects in the multivariate analyses. It must also be acknowledged that the sample size limits the extent to which findings can be generalized to other workplaces.

Also, as samples were collected and assayed at the two sites more than two years apart, with some small differences between sites in the items included in the JLI, concurrent analysis of data from both sites did not occur and so subsequent comparisons between the two sites was limited.
Chapter 6

DATA PREPARATION AND DEVELOPMENT OF THE JOBLOAD INDEX

This chapter describes the data preparation and data collection procedures. Both study site responses from the job analysis, JLI items, and urine hormone sampling were collected, allocated a numerical identification code, and entered into the database of SPSS version 11.4.

DATA PREPARATION

The accuracy of data entry was checked using the procedures recommended by Tabachnik and Fidell (2001:56-110), and prior to analysis, all reverse-scored variables were recoded (Mesiter, 1989; Shaughnessy & Zexhmeister, 1997). All subjects from both sites provided completed data sets for the weekly JLI responses. Where missing data was detected for the ‘once only’ data the team mean for each response was calculated and these means were then used to replace any missing values prior to analysis (Tabachnik & Fidell, 2001:56-107).

Data Transformations

The mean, standard deviation, skew, kurtosis and standard errors were checked and any data transformations required followed the procedures recommended by Tabachnik and Fidell (2001), and Norman and Streiner (2000). These details are shown at Appendix 6, Table 6.1-2 for each variable. All data transformations are shown in full in Appendix 6, Tables 6.3 and described where appropriate under the Tables describing the Principal Components Analysis (PCA). The descriptive statistics for the transformed constructs groups (driven by the PCA described below) are at Appendix 6, Table 6.4-5. All dependent variables (DV) were normally distributed and retained in the original metric to facilitate data interpretation.

Factor Analysis Approach to the development of constructs for the JLI

The identification of constructs was based both on the conceptual model and on results of factor analyses. While the total number of JLI responses gathered for site one was 294, this was derived from 124 subjects – a sample size that would usually be considered poor for factor analysis (Tabachnik & Fidell, 2001). However, the minimum acceptable ‘subject to independent variables ratio’ \( N:p \) is still a matter of dispute (Tabachnik & Fidell, 2001; MacCallum, Widaman, Zhang & Hong, 1999; Grimm & Yarnold, 1998; and Norman & Streiner, 2001), and

---

12 Data related to job characteristics that was not considered likely to change over the course of the study was only collected once from each subject at the end of the study period. Subjects who were known to be planning to leave the department were asked to complete this section prior to departure.
MacCallum et al. (1999:96) suggest that factor analysis with smaller sample sizes (n<100) are still valid if:

1. the communalities are good (.5 or above) for most indicators,
2. there are well determined factors, and
3. the computations converge to a proper solution.

To ensure that the factorial analysis fell well within acceptable statistical bounds, the following rules were used:

2. If communalities were noted to be low (.2, .3, or .4) but theoretically congruent the N:p ratio was then increased to 10:1 (120: 12 variables).
3. Whenever possible, factors were ‘over-determined’ MacCallum et al. (1999) suggested that to ensure that highly acceptable percentages (97.1-100%) of convergence and admissible solutions are achieved for a sample size of 100 the recommended Independent to Dependent Variable ratio (p:r) and communality level is:
   - o 10:3 during high communality (.6-.8)
   - o 20:3 during wide communality (.2-.8)
   - o 20:3 during low communality (.2, .3, .4)
4. Finally, the results were all checked against the JobLoad Model to ensure that they had converged to a ‘proper solution’.

The JLI variables were considered to be the observed indicators of one or more underlying latent constructs. Those variables that were conceptually related to each other, as indicated by previous research, were grouped together for initial analysis and carried out in accordance with the rules for analysis noted above. Data was explored using Principal Component Analysis (SPSS version 11.4) using the rotation method Varimax with Kaiser Normalization. The communalities of groups of variables were then examined and any variable that was less than .4 excluded from that group of variables. The number of factors was then determined by examining the results from the ‘Total Variance Explained’ tables and the ‘Scree Plots’. The data analysis process was then repeated to gain an appropriate rotated factor matrix.

Kaiser-Meyer-Olkin Measure of sampling adequacy was used to check the adequacy of individual variables and any noted to be less than .60 were considered for removal as advised by Norman and Streiner (2000). Wherever possible, at least three variables were used in a factor,
where this was not possible it is acknowledged that it would be recommended in future studies that the number of items be increased (Tabachnick & Fidell, 2001).

From the results of the literature review, these domains were then further subdivided into preliminary constructs to ensure that the subject to variable ratio 5:1 was not exceeded (as noted above). The data was then analysed (using principal components) to test the reliability of the proposed factors groupings across the data set. Factor analysis processes were:

1. initially using data from all 124 subjects who participated in the study
2. rerun using data from the 69 subjects with high working hours (56 hours plus per week) and finally,
3. rerun using data from the 117 subjects with standard working hours (35-45 hours per week);
4. Finally when the components were settled rerun using the whole data set.

Those variables listed in the following pages that were thought to be conceptually related to more than one factor are indicated as appropriate. The PCAs were undertaken using both the transformed and untransformed data from three different cross sections of the samples.\(^{13}\) The following represents:

- 1UT - untransformed data from the maximum number of subjects from round one
- 1T - transformed data from the maximum number of subjects from round one
- 2UT - untransformed data from the maximum number of subjects from round two
- 2T - transformed data from the maximum number of subjects from round two
- 3UT - untransformed data from the maximum number of subjects from round three
- 3T - transformed data from the maximum number of subjects from round three.

Variables were ordered and grouped by size of loading to facilitate interpretation. When the structure of the factor was decided, a standardized score for each variable within the construct was created. These were then summed and divided by the number of variables to create the ‘construct score’. This method was chosen rather than using the score created by the PCA process as the data which involved multiple responses from the one subject from all rounds were needed. Principal Components Analysis (PCA) was then performed using Varimax rotation with Kaiser Normalization. In the following Tables, constructs are colour coded to more easily show where each item fell. Some symbols have been inserted to show the method of transformation prior to PCA where a:

\(^{13}\) As was expected the results using transformed and untransformed data were similar so that the decision to use transformed data where possible in future analysis was made.
\(^{14}\) n = 125
\(^{15}\) n = 120
\(^{16}\) n = 119

92
a) + indicates reflected and Square Root Transformation *-1;
b) SQRT indicates Square Root Transformation;
c) # indicates reflected and LOG 10 *-1 transformation; and
d) LOG10 indicates LOG 10 transformation.

DOMAIN – PERSONAL & NON-WORK RELATED FACTORS

Sub construct: Personal & Non-Work related Factors Affecting Coping Capacity

None of these variables were transformed and all were retained in their original metric:
stressful problems with family or friends this week; conflict between your work and home
demands this week; physical injuries or illness this week; age; gender; education level; and
experience created from the average of two items ‘length of time in job’ and ‘at current level’.

DOMAIN – WORK DEMANDS

General Job Demands

The Total Working Hours Score was used and this variable did not require transformation prior to
inclusion in any analysis. This variable was subsequently included in an analysis with the general
and temporal demands.

As a number of the work demand variables could conceptually belong in more than one factor, the
allocation of these variables to a factor was decided via the PCA. These variables are noted below.

Group One: General & Temporal Demands Items

Factor analysis results for each data collection round using both transformed and untransformed
data relating to the general and temporal demands items are listed in Table 6.1 below.
Table 6.1. Factor Analysis General Job Demands items using transformed &
untransformed data (3 rounds)

<table>
<thead>
<tr>
<th>Variables</th>
<th>1 UT</th>
<th>1 T</th>
<th>2 UT</th>
<th>2 T</th>
<th>3 UT</th>
<th>3 T</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Too much work to do in available time</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workload was excessive</td>
<td>.807</td>
<td>.689</td>
<td>.704</td>
<td>.637</td>
<td>.803</td>
<td>.774</td>
</tr>
<tr>
<td>Work days hectic</td>
<td>.728</td>
<td>.656</td>
<td>.731</td>
<td>.678</td>
<td>.812</td>
<td>.769</td>
</tr>
<tr>
<td>NOT time to take it easy and get work done</td>
<td>.670</td>
<td>.744</td>
<td>.753</td>
<td>.764</td>
<td>.732</td>
<td>.730</td>
</tr>
<tr>
<td>NOT time to work in a relaxed way</td>
<td>.818</td>
<td>.808</td>
<td>.778</td>
<td>.766</td>
<td>.828</td>
<td>.809</td>
</tr>
<tr>
<td>Work very hard</td>
<td>.660</td>
<td>.549</td>
<td>.730</td>
<td>.751</td>
<td>.772</td>
<td>.758</td>
</tr>
<tr>
<td>NOT have enough time to get the job done</td>
<td>.684</td>
<td>.691</td>
<td>.598</td>
<td>.416</td>
<td>.733</td>
<td>.639</td>
</tr>
<tr>
<td>NOT able to do non-urgent tasks</td>
<td>.629</td>
<td>.683</td>
<td>.732</td>
<td>.675</td>
<td>.684</td>
<td>.716</td>
</tr>
<tr>
<td>NOT let mind wander and still do the work</td>
<td>.446</td>
<td>.480</td>
<td>.704</td>
<td>.798</td>
<td>.644</td>
<td>.497</td>
</tr>
<tr>
<td>Backlog' of work</td>
<td>.613</td>
<td>.601</td>
<td>.694</td>
<td>.564</td>
<td>.679</td>
<td>.597</td>
</tr>
<tr>
<td>Time Pressures and Deadlines</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deadlines</td>
<td>.675</td>
<td>.746</td>
<td>.833</td>
<td>.736</td>
<td>.600</td>
<td>.811</td>
</tr>
<tr>
<td>Worked on very urgent tasks</td>
<td>.773</td>
<td>.766</td>
<td>.710</td>
<td>.700</td>
<td>.650</td>
<td>.475</td>
</tr>
<tr>
<td>Excessive time pressure</td>
<td>.637</td>
<td>.514</td>
<td>.578</td>
<td>.511</td>
<td>.573</td>
<td>.650</td>
</tr>
<tr>
<td>Have to work fast</td>
<td>.801</td>
<td>.753</td>
<td>.738</td>
<td>.726</td>
<td>.716</td>
<td>.631</td>
</tr>
<tr>
<td>Big effort required</td>
<td>.524</td>
<td>.524</td>
<td>.579</td>
<td>.616</td>
<td>.523</td>
<td>.586</td>
</tr>
<tr>
<td>Other people's work made conflicting demands on your time</td>
<td>.445</td>
<td>.486</td>
<td>.542</td>
<td>.533</td>
<td>.581</td>
<td>.666</td>
</tr>
<tr>
<td>Responsibility</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monitor other people's performance</td>
<td>.850</td>
<td>.808</td>
<td>.820</td>
<td>.768</td>
<td>.844</td>
<td>.861</td>
</tr>
<tr>
<td>Others welfare</td>
<td>.847</td>
<td>.891</td>
<td>.836</td>
<td>.863</td>
<td>.795</td>
<td>.718</td>
</tr>
<tr>
<td>Managing other people's performance</td>
<td>.847</td>
<td>.891</td>
<td>.836</td>
<td>.863</td>
<td>.795</td>
<td>.718</td>
</tr>
<tr>
<td>Organize other people</td>
<td>.837</td>
<td>.798</td>
<td>.845</td>
<td>.832</td>
<td>.879</td>
<td>.892</td>
</tr>
<tr>
<td>Staying within budget</td>
<td>.814</td>
<td>.774</td>
<td>.801</td>
<td>.771</td>
<td>.850</td>
<td>.835</td>
</tr>
<tr>
<td>Expensive equipment or materials</td>
<td>.474</td>
<td>.419</td>
<td>.478</td>
<td>.606</td>
<td>.488</td>
<td>.511</td>
</tr>
<tr>
<td>Unpleasant Working Hours</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Worked at times that didn’t suit you</td>
<td>.782</td>
<td>.638</td>
<td>.782</td>
<td>.658</td>
<td>.804</td>
<td>.635</td>
</tr>
<tr>
<td>Worked longer hours than you preferred</td>
<td>.746</td>
<td>.712</td>
<td>.625</td>
<td>.593</td>
<td>.683</td>
<td>.601</td>
</tr>
<tr>
<td>Increasing Workload Pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workload increasing</td>
<td>.817</td>
<td>.764</td>
<td>.792</td>
<td>.621</td>
<td>.856</td>
<td>.637</td>
</tr>
<tr>
<td>Pressure to work overtime</td>
<td>.573</td>
<td>.472</td>
<td>.609</td>
<td>.616</td>
<td>.345</td>
<td>.647</td>
</tr>
</tbody>
</table>

94
To confirm the structure of the scales, the reliability coefficients were then calculated for the scales for each site using the grouping of the variables indicated above.

- **Too Much Work To Do In The Available Time**- for the 9 items for site one was Alpha = .84 and for site two .91.
- **Time Pressures and Deadlines**- for the 6 items for site one was Alpha = .72, and Site two Alpha = .89.
- **Responsibility**- for the 6 items for site one was Alpha = .87 and for site two Alpha = .91
- **Unpleasant Working Hours**- for the 2 items for site one was Alpha = .51, Standardized item alpha = .51 and for site two Alpha = .72
- **Increasing Workload Pressure**- for the 2 items for site one was Alpha = .28, and for site two alpha = .25

**Group Two: Specific Work Demands Items**

Factor analysis results for each data-collection round using both transformed and untransformed data relating to the specific work demands items are listed in Table 6.3.

### Table 6.2. Factor Analysis Specific Work demands items using transformed and untransformed data (3 rounds)

<table>
<thead>
<tr>
<th>Static Physical Demands</th>
<th>1 UT</th>
<th>1 T</th>
<th>2 UT</th>
<th>2 T</th>
<th>3 UT</th>
<th>3 T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precise, accurate movements*</td>
<td>.791</td>
<td>.785</td>
<td>.781</td>
<td>.786</td>
<td>.819</td>
<td>.790</td>
</tr>
<tr>
<td>Sitting/standing same position long periods*</td>
<td>.745</td>
<td>.772</td>
<td>.497</td>
<td>.526</td>
<td>.612</td>
<td>.750</td>
</tr>
<tr>
<td>Maintaining awkward body/arm positions</td>
<td>.616</td>
<td>.631</td>
<td>.525</td>
<td>.621</td>
<td>.618</td>
<td>.692</td>
</tr>
<tr>
<td>Cognitive Demands</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complex decision-making*</td>
<td>.678</td>
<td>.774</td>
<td>.465</td>
<td>.783</td>
<td>.697</td>
<td>.650</td>
</tr>
<tr>
<td>Remembering different things#</td>
<td>.783</td>
<td>.733</td>
<td>.637</td>
<td>.672</td>
<td>.767</td>
<td>.720</td>
</tr>
<tr>
<td>Rapid decision-making*</td>
<td>.697</td>
<td>.697</td>
<td>.594</td>
<td>.642</td>
<td>.660</td>
<td>.618</td>
</tr>
<tr>
<td>Dynamic Physical Demands or Risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strenuous forceful actions LOG10</td>
<td>.789</td>
<td>.752</td>
<td>.845</td>
<td>.810</td>
<td>.858</td>
<td>.826</td>
</tr>
<tr>
<td>Risk of injury or illness</td>
<td>.726</td>
<td>.827</td>
<td>.812</td>
<td>.763</td>
<td>.848</td>
<td>.777</td>
</tr>
<tr>
<td>Walk fast</td>
<td>.547</td>
<td>.661</td>
<td>.490</td>
<td>.427</td>
<td>.595</td>
<td>.559</td>
</tr>
</tbody>
</table>
The reliability coefficients were then calculated for the scales for each site using the grouping of the variables indicated above.

- **Important Consequences of Errors** (single item construct)
- **Emotional Demands** - 4 items for site one was Alpha = .76 and for site two alpha = .78.
- **Cognitive Demands** - 3 items for site one was Alpha = .73 and for site two was Alpha = .80.

However, the reliability coefficients for the following scales were of concern:

- **Static Physical Demands** - 3 items for site one was Alpha = .43 and for site two alpha = .23.
- **Dynamic Physical Demands** - 3 items for site one was Alpha = .25 and for site two Alpha = .60.
- **Demand for Care and Vigilance** - 5 items for site one was Alpha = .44, and site two alpha = .24.

It is noted that whilst the reliability coefficients of some of these constructs were unacceptably low, nevertheless in the PCA analysis all the correlations were above .4. These constructs are all highly multidimensional and the literature indicates that they are clear risk factors for both fatigue and musculoskeletal discomfort (see Chapter 9-10). The low Alphas were therefore taken as evidence of their multi dimensional nature. It was also noted that the distribution for the item ‘work required strenuous or forceful actions’ was not normal (skew = 5.185 SE .26 and kurtosis = 34.72 SE .514), reflecting that within these job types most staff did not usually perform strenuous or forceful

### Table 6.2. continued

<table>
<thead>
<tr>
<th>Emotional Demands</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dealt people who might be hurt or upset</td>
<td>.828</td>
<td>.817</td>
<td>.816</td>
<td>.822</td>
<td>.790</td>
<td>.792</td>
</tr>
<tr>
<td>Dealt with people aggressive or unpleasant</td>
<td>.731</td>
<td>.746</td>
<td>.840</td>
<td>.844</td>
<td>.764</td>
<td>.784</td>
</tr>
<tr>
<td>Listened sympathetically to others</td>
<td>.696</td>
<td>.704</td>
<td>.752</td>
<td>.763</td>
<td>.735</td>
<td>.743</td>
</tr>
<tr>
<td>Hid feelings from others</td>
<td>.653</td>
<td>.682</td>
<td>.452</td>
<td>.452</td>
<td>.645</td>
<td>.626</td>
</tr>
</tbody>
</table>

### Consequences of errors

| Errors had important consequences*                                             | .826| .671| .617| .751| .524| .742|

### Demand for Care Vigilance (Perceptual Demands)

| Careful looking or listening #                                               | .562| .464| .720| .719| .679| .586|
| Work repetitive                                                               | .698| .714| .728| .706| .502| .738|
| Working carefully#                                                            | .404| .544| .749| .713| .620| .652|
| Monotonous or boring                                                          | -.573| -.500| -.803| -.781| .763| .515|
| Lot of concentration#                                                         | .536| .547| .500| .535| .650| .797|

The reliability coefficients were then calculated for the scales for each site using the grouping of the variables indicated above.
movements. So whilst the decision was taken to retain the construct for use where this was essential, wherever possible the items were to be added as individual items to the analysis to ensure that the sensitivity of the variable as a predictor, particularly for Bodily Discomfort, was not lost.

**Group Three: Contextual Demands & Impediments Items**

Factor analysis results for each data-collection round using both transformed and untransformed data relating to the contextual demands and impediment items are listed in Table 6.3.

**Table 6.3. Factor Analysis Contextual Demands and Impediments items using transformed & untransformed data (3 rounds)**

<table>
<thead>
<tr>
<th>Factor</th>
<th>1 UT</th>
<th>1 T</th>
<th>2 UT</th>
<th>2 T</th>
<th>3 UT</th>
<th>3 T</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interruptions and Disruptions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leave one task incomplete in order to work on another*</td>
<td>.780</td>
<td>.757</td>
<td>.442</td>
<td>.612</td>
<td>.587</td>
<td>.604</td>
</tr>
<tr>
<td>Interruptions or disturbances *</td>
<td>.665</td>
<td>.674</td>
<td>.728</td>
<td>.714</td>
<td>.472</td>
<td>.524</td>
</tr>
<tr>
<td>NOT time to plan coordinate job</td>
<td>.631</td>
<td>.643</td>
<td>.810</td>
<td>.818</td>
<td>.830</td>
<td>.811</td>
</tr>
<tr>
<td>NOT able to do tasks thoroughly</td>
<td>.574</td>
<td>.600</td>
<td>.695</td>
<td>.678</td>
<td>.740</td>
<td>.734</td>
</tr>
<tr>
<td>NOT able to think creatively about your job</td>
<td>.726</td>
<td>.700</td>
<td>.729</td>
<td>.714</td>
<td>.581</td>
<td>.592</td>
</tr>
<tr>
<td><strong>Environmental &amp; informational impediments</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NOT satisfactory information or advice SQRT</td>
<td>.705</td>
<td>.730</td>
<td>.707</td>
<td>.732</td>
<td>.589</td>
<td>.648</td>
</tr>
<tr>
<td>Held up by others</td>
<td>.625</td>
<td>.551</td>
<td>.591</td>
<td>.611</td>
<td>.723</td>
<td>.750</td>
</tr>
<tr>
<td>NOT satisfactory work equipment and tools SQRT</td>
<td>.425</td>
<td>.474</td>
<td>.674</td>
<td>.746</td>
<td>.757</td>
<td>.405</td>
</tr>
<tr>
<td>Unnecessary ‘red tape’</td>
<td>.527</td>
<td>.537</td>
<td>.694</td>
<td>.692</td>
<td>.542</td>
<td>.548</td>
</tr>
<tr>
<td>Problems faulty equipment or inefficient procedures</td>
<td>.681</td>
<td>.580</td>
<td>nr</td>
<td>nr</td>
<td>.656</td>
<td>.625</td>
</tr>
<tr>
<td>NOT satisfactory staffing</td>
<td>.724</td>
<td>.702</td>
<td>.608</td>
<td>.579</td>
<td>.530</td>
<td>.433</td>
</tr>
<tr>
<td><strong>Performance Uncertainty</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trouble working out whether you're doing your job well or poorly SQRT</td>
<td>.630</td>
<td>.691</td>
<td>.652</td>
<td>.673</td>
<td>.767</td>
<td>.731</td>
</tr>
<tr>
<td>Work is not closely supervised*</td>
<td>-.521</td>
<td>-.466</td>
<td>-.603</td>
<td>-.430</td>
<td>-.510</td>
<td>.785</td>
</tr>
<tr>
<td>Usually do not know if work satisfactory LOG10</td>
<td>.493</td>
<td>.570</td>
<td>.718</td>
<td>.748</td>
<td>nr</td>
<td>nr</td>
</tr>
</tbody>
</table>

The reliability coefficients were then calculated for the scales for each site using the grouping of the variables indicated above.

- *Interruptions and Disruptions* - for 5 items for site one was Alpha = .60, for site two the Alpha = .80.
• Environmental & Informational Impediments - for 6 items for site one was Alpha = .56, for site two Alpha = .64.

• Performance Uncertainty - for 3 items for site one Alpha = .37 and for site two Alpha = .31.

Group Four: Contextual Demands and Impediments Items (continued)

Factor analysis results for each data collection round using both transformed and untransformed data relating to the contextual demands and impediment items are listed in Table 6.4.

Table 6.4. Factor Analysis Contextual Demands and Impediments items using transformed & untransformed data (3 rounds)

<table>
<thead>
<tr>
<th></th>
<th>1 UT</th>
<th>1 T</th>
<th>2 UT</th>
<th>2 T</th>
<th>3 UT</th>
<th>3 T</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Workload Variance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concentration varies from week to week?</td>
<td>.929</td>
<td>.929</td>
<td>.895</td>
<td>.927</td>
<td>.908</td>
<td>.907</td>
</tr>
<tr>
<td>Workload vary from week to week</td>
<td>.860</td>
<td>.859</td>
<td>.868</td>
<td>.870</td>
<td>.824</td>
<td>.826</td>
</tr>
<tr>
<td>Difficulty and complexity of your work vary</td>
<td>.834</td>
<td>.834</td>
<td>.851</td>
<td>.842</td>
<td>.810</td>
<td>.808</td>
</tr>
<tr>
<td>Required work rate varies</td>
<td>.766</td>
<td>.764</td>
<td>.791</td>
<td>.783</td>
<td>.808</td>
<td>.806</td>
</tr>
<tr>
<td><strong>Career Uncertainty /Ambiguity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uncertain about your future career prospects</td>
<td>.906</td>
<td>.919</td>
<td>Nr</td>
<td>.956</td>
<td>.948</td>
<td>.953</td>
</tr>
<tr>
<td>Uncertain job skills will be of use value five years from now.</td>
<td>.835</td>
<td>.836</td>
<td>.861</td>
<td>.861</td>
<td>.873</td>
<td>.875</td>
</tr>
<tr>
<td>Uncertain about whether you could get another job if you lost this one</td>
<td>.759</td>
<td>.754</td>
<td>.769</td>
<td>.773</td>
<td>.796</td>
<td>.795</td>
</tr>
<tr>
<td>Uncertain about what your job responsibilities will be in six months time</td>
<td>.738</td>
<td>.740</td>
<td>.764</td>
<td>.762</td>
<td>.718</td>
<td>.721</td>
</tr>
<tr>
<td><strong>Uncertainty about work requirements (Role clarity)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uncertain how much, overall expected to get done $\sqrt{ }$</td>
<td>.858</td>
<td>.862</td>
<td>.796</td>
<td>.795</td>
<td>.799</td>
<td>.801</td>
</tr>
<tr>
<td>Uncertain how to do the tasks required $\sqrt{ }$</td>
<td>.742</td>
<td>.747</td>
<td>.646</td>
<td>.707</td>
<td>.740</td>
<td>.748</td>
</tr>
<tr>
<td>Uncertain what to achieve</td>
<td>.742</td>
<td>.743</td>
<td>.763</td>
<td>.761</td>
<td>.651</td>
<td>.686</td>
</tr>
<tr>
<td>Uncertain performance standard $\sqrt{ }$</td>
<td>.694</td>
<td>.706</td>
<td>.764</td>
<td>.766</td>
<td>.735</td>
<td>.736</td>
</tr>
<tr>
<td>Uncertain priorities between conflicting work</td>
<td>.672</td>
<td>.711</td>
<td>.752</td>
<td>.751</td>
<td>.708</td>
<td>.737</td>
</tr>
</tbody>
</table>

The reliability coefficients were then calculated for the scales for each site using the grouping of the variables indicated above.

• Workload Variance- for 4 items for site one was Alpha = .88, and for site two Alpha = .90

• Career Uncertainty - for 3 items was Alpha = .63, and for site two Alpha = .78. For all 4 items: Uncertain job skills will be of use/value five years from now; Uncertain about whether
you could get another job if you lost this one; Uncertain about what your job responsibilities will be in six months time; and Uncertain about your future career prospects Site one Alpha =.98 and for site two Alpha = .83.

• **Uncertainty about Work Requirements**- for 5 items for site one was Alpha = .66 and for site two Alpha = .85.

**DOMAIN – SUPPORT**

**Group Five: Coworker Relationships Items**

Factor analysis results for each data collection round using both transformed and untransformed data relating to the coworker relationship items are listed in the Table 6.5 below.

**Table 6.5. Factor Analysis - Coworker Relationships this week items using transformed & untransformed data (3 rounds)**

<table>
<thead>
<tr>
<th>Poor Coworkers Support this week</th>
<th>1 UT</th>
<th>1 T</th>
<th>2 UT</th>
<th>2 T</th>
<th>3 UT</th>
<th>3 T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coworkers NOT friendly</td>
<td>.765</td>
<td>.776</td>
<td>.689</td>
<td>.707</td>
<td>.758</td>
<td>.739</td>
</tr>
<tr>
<td>Coworkers not supportive</td>
<td>.758</td>
<td>.755</td>
<td>.781</td>
<td>.776</td>
<td>.766</td>
<td>.766</td>
</tr>
<tr>
<td>Coworkers NOT helpful</td>
<td>.744</td>
<td>.750</td>
<td>.671</td>
<td>.796</td>
<td>.783</td>
<td>.783</td>
</tr>
<tr>
<td>Dissatisfied interactions with c-workers</td>
<td>.674</td>
<td>.658</td>
<td>.748</td>
<td>.763</td>
<td>.697</td>
<td>.711</td>
</tr>
<tr>
<td>Dissatisfied coworkers performance</td>
<td>.641</td>
<td>.656</td>
<td>.733</td>
<td>.781</td>
<td>.726</td>
<td>.740</td>
</tr>
<tr>
<td>Poor Coworker Support and Cohesion last six months</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coworkers NOT work well together</td>
<td>.895</td>
<td>.858</td>
<td>.874</td>
<td>.818</td>
<td>.881</td>
<td>.842</td>
</tr>
<tr>
<td>Coworkers NOT helpful</td>
<td>.825</td>
<td>.868</td>
<td>.812</td>
<td>.866</td>
<td>.801</td>
<td>.818</td>
</tr>
<tr>
<td>Coworkers NOT friendly</td>
<td>.804</td>
<td>.825</td>
<td>.800</td>
<td>.825</td>
<td>.777</td>
<td>.802</td>
</tr>
<tr>
<td>Coworkers NOT competent</td>
<td>.796</td>
<td>.811</td>
<td>.828</td>
<td>.827</td>
<td>.803</td>
<td>.819</td>
</tr>
<tr>
<td>Group morale generally NOT good</td>
<td>.631</td>
<td>.617</td>
<td>.642</td>
<td>.634</td>
<td>.693</td>
<td>.701</td>
</tr>
<tr>
<td>Conflict this week</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conflict between your workgroup and others</td>
<td>.799</td>
<td>.798</td>
<td>.723</td>
<td>.722</td>
<td>.844</td>
<td>.842</td>
</tr>
<tr>
<td>Negative feedback or criticism from supervisor/co workers</td>
<td>.684</td>
<td>.668</td>
<td>.777</td>
<td>.786</td>
<td>.704</td>
<td>.704</td>
</tr>
<tr>
<td>Conflict within people within workgroup</td>
<td>.673</td>
<td>.711</td>
<td>.728</td>
<td>.716</td>
<td>.739</td>
<td>.745</td>
</tr>
<tr>
<td>Conflict between you and your supervisor</td>
<td>.501</td>
<td>.553</td>
<td>.593</td>
<td>.610</td>
<td>.472</td>
<td>.477</td>
</tr>
</tbody>
</table>
The reliability coefficients were then calculated for the scales for each site using the grouping of the variables indicated above.

- **Coworkers Support** this week- for 5 items for site one was Alpha = .81 and for site two Alpha = .81.
- **Coworker Support and Cohesion** last six months- for 5 items for site one was Alpha = .79 and for site two Alpha = .70.
- **Conflict** this week- for 4 items for site one was Alpha = .54, and for site two Alpha = .67.

**Group Six: Supervisor/Management Communications & Attitudes Items**

Factor analysis results for each data collection round using both transformed and untransformed data relating to the supervisor management communications and attitudes are listed in Table 6.6 below.

**Table 6.6. Factor Analysis Supervisor/Management Communications & Attitudes this week items using transformed & untransformed data (3 rounds)**

<table>
<thead>
<tr>
<th>Poor Supervisor Support this week</th>
<th>1 UT</th>
<th>1 T</th>
<th>2 UT</th>
<th>2 T</th>
<th>3 UT</th>
<th>3 T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissatisfied supervisor’s appreciation of work performance</td>
<td>.813</td>
<td>.811</td>
<td>.790</td>
<td>.778</td>
<td>.825</td>
<td>.775</td>
</tr>
<tr>
<td>Superiors NOT supportive</td>
<td>.831</td>
<td>.829</td>
<td>.853</td>
<td>.825</td>
<td>.823</td>
<td>.834</td>
</tr>
<tr>
<td>Supervisor NOT give enough time attention</td>
<td>.784</td>
<td>.784</td>
<td>.782</td>
<td>.792</td>
<td>.795</td>
<td>.818</td>
</tr>
<tr>
<td>Supervisor NOT helpful</td>
<td>.760</td>
<td>.762</td>
<td>.803</td>
<td>.813</td>
<td>.801</td>
<td>.817</td>
</tr>
<tr>
<td>NO positive feedback</td>
<td>.660</td>
<td>.670</td>
<td>.535</td>
<td>.565</td>
<td>.602</td>
<td>.531</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Poor Senior Management Communications and Attitudes</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher-level managers NOT supportive</td>
<td>.529</td>
<td>.403</td>
<td>.588</td>
<td>.581</td>
<td>.747</td>
<td>.755</td>
</tr>
<tr>
<td>Higher level managers DO NOT understand</td>
<td>.803</td>
<td>.801</td>
<td>.835</td>
<td>.835</td>
<td>.827</td>
<td>.809</td>
</tr>
<tr>
<td>People in other sections DO NOT understand</td>
<td>.774</td>
<td>.780</td>
<td>.777</td>
<td>.785</td>
<td>.679</td>
<td>.678</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Poor Supervisors Support -last six months</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Supervisor NOT supportive^</td>
<td>.833</td>
<td>.842</td>
<td>.791</td>
<td>.795</td>
<td>.729</td>
<td>.830</td>
</tr>
<tr>
<td>Supervisor NOT good organizer</td>
<td>.790</td>
<td>.760</td>
<td>.812</td>
<td>.797</td>
<td>.786</td>
<td>.669</td>
</tr>
<tr>
<td>Supervisor NOT understand demands difficulties</td>
<td>.773</td>
<td>.789</td>
<td>.674</td>
<td>.659</td>
<td>.691</td>
<td>.675</td>
</tr>
<tr>
<td>Supervisor NOT aware how hard you work</td>
<td>.770</td>
<td>.795</td>
<td>.662</td>
<td>.663</td>
<td>.629</td>
<td>.664</td>
</tr>
<tr>
<td>Supervisor does NOT care about welfare</td>
<td>.726</td>
<td>.743</td>
<td>.606</td>
<td>.615</td>
<td>.533</td>
<td>.719</td>
</tr>
<tr>
<td>Supervisor NOT aware quality of work</td>
<td>.615</td>
<td>.651</td>
<td>.528</td>
<td>.555</td>
<td>.662</td>
<td>.660</td>
</tr>
</tbody>
</table>
The reliability coefficients were then calculated for the scales for each site using the grouping of the variables indicated above.

- **Supervisor Not Supportive** this week - for 5 items for site one was Alpha = .73 for site two Alpha = .86.
- **Supervisor Not Supportive** last six months - for 5 items for site one was Alpha = .69 and Site two Alpha = .90.
- **Senior Management Communications and Attitudes Score** - for 3 items for site one was Alpha = .70 and for site two Alpha = .69.

**DOMAIN – CONTROL**

**Group Seven: - Job Factor Items**

Factor analysis results for each data collection round using both transformed and untransformed data relating to the job factors are listed in the Table 6.7 below.
Table 6.7. Factor Analysis Job Factors and Characteristics items using transformed & untransformed data (3 rounds)

<table>
<thead>
<tr>
<th></th>
<th>1 UT</th>
<th>1 T</th>
<th>2 UT</th>
<th>2 T</th>
<th>3 UT</th>
<th>3 T</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Poor Skill Utilization</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NOT high level of skill ( \log_{10} )</td>
<td>.844</td>
<td>.828</td>
<td>.843</td>
<td>.811</td>
<td>.569</td>
<td>.844</td>
</tr>
<tr>
<td>NOT learn new things ( \log_{10} )</td>
<td>.812</td>
<td>.795</td>
<td>.823</td>
<td>.806</td>
<td>.872</td>
<td>.792</td>
</tr>
<tr>
<td>NOT use skills and knowledge ( \log_{10} )</td>
<td>.725</td>
<td>.681</td>
<td>.772</td>
<td>.751</td>
<td>.569</td>
<td>.764</td>
</tr>
<tr>
<td>NOT creative</td>
<td>.543</td>
<td>.553</td>
<td>.564</td>
<td>.485</td>
<td>.791</td>
<td>.508</td>
</tr>
<tr>
<td></td>
<td>.508</td>
<td>.486</td>
<td>.425</td>
<td>.503</td>
<td>.483</td>
<td>.533</td>
</tr>
<tr>
<td><strong>Lack of Work Variety</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NOT variety of different things SQRT</td>
<td>.523</td>
<td>.518</td>
<td>.705</td>
<td>.708</td>
<td>.564</td>
<td>.549</td>
</tr>
<tr>
<td>NOT involves a lot of repetitive work</td>
<td>.560</td>
<td>.628</td>
<td>.661</td>
<td>.682</td>
<td>.631</td>
<td>.658</td>
</tr>
<tr>
<td>Little freedom to decide work pace</td>
<td>-.725</td>
<td>-.687</td>
<td>-.525</td>
<td>-.523</td>
<td>-.476</td>
<td>-.689</td>
</tr>
<tr>
<td><strong>Low Decision Latitude</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NOT freedom decide order do things</td>
<td>.871</td>
<td>.873</td>
<td>.841</td>
<td>.843</td>
<td>.851</td>
<td>.849</td>
</tr>
<tr>
<td>NOT freedom to decide when to take breaks</td>
<td>.844</td>
<td>.840</td>
<td>.782</td>
<td>.782</td>
<td>.773</td>
<td>.782</td>
</tr>
<tr>
<td>NOT freedom decide starting/finishing times</td>
<td>.833</td>
<td>.834</td>
<td>.744</td>
<td>.743</td>
<td>.764</td>
<td>.763</td>
</tr>
<tr>
<td>NOT allowed make decisions on own</td>
<td>.523</td>
<td>.524</td>
<td>.645</td>
<td>.638</td>
<td>.673</td>
<td>.662</td>
</tr>
<tr>
<td></td>
<td>.493</td>
<td>.487</td>
<td>.461</td>
<td>.471</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Little Influence</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Little freedom to decide how do work</td>
<td>.666</td>
<td>.438</td>
<td>.525</td>
<td>.530</td>
<td>.459</td>
<td>.460</td>
</tr>
<tr>
<td>NOT a lot of say</td>
<td>.449</td>
<td>.692</td>
<td>.591</td>
<td>.600</td>
<td>.517</td>
<td>.544</td>
</tr>
<tr>
<td>Opinions NOT taken seriously</td>
<td>.833</td>
<td>.820</td>
<td>.848</td>
<td>.824</td>
<td>.863</td>
<td>.836</td>
</tr>
<tr>
<td>NOT opportunity develop own abilities</td>
<td>.705</td>
<td>.703</td>
<td>.624</td>
<td>.657</td>
<td>.732</td>
<td>.751</td>
</tr>
<tr>
<td></td>
<td>.404</td>
<td>.438</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The reliability coefficients were then calculated for the scales for each site using the grouping of the variables indicated above.

- **Low Skill Utilization** - for 4 items for site one Alpha = .99 and Site two Alpha = .85.
- **Lack of Work Variety**- for 3 items for site one Alpha = .98, and Site one Alpha = .48.
- **Low Decision Latitude** - for 4 items for site one Alpha = .79 and Site two Alpha = .74.
- **Little Influence**- for 4 items for site one Alpha = .70 and Site two Alpha = .86.
GROUP EIGHT – SOURCES OF DISSATISFACTION

Factor analysis results for each data collection round using both transformed and untransformed data relating to the dissatisfaction items are listed in the Table 6.8 below.

Table 6.8. Factor Analysis Job-Related Reward/Dissatisfaction items using transformed & untransformed data (3 rounds)

<table>
<thead>
<tr>
<th></th>
<th>1 UT</th>
<th>1 T</th>
<th>2 UT</th>
<th>2 T</th>
<th>3 UT</th>
<th>3 T</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reward Dissatisfaction</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work NOT appropriate for level</td>
<td>.803</td>
<td>.798</td>
<td>.712</td>
<td>.685</td>
<td>.568</td>
<td>.482</td>
</tr>
<tr>
<td>NOT adequately rewarded</td>
<td>.585</td>
<td>.550</td>
<td>.591</td>
<td>.559</td>
<td>.481</td>
<td>.500</td>
</tr>
<tr>
<td>Dissatisfied with performance appraisal process</td>
<td>.562</td>
<td>.526</td>
<td>.663</td>
<td>.679</td>
<td>.485</td>
<td>.510</td>
</tr>
<tr>
<td>Dissatisfied level of responsibility</td>
<td>.555</td>
<td>.574</td>
<td>.513</td>
<td>.501</td>
<td>.738</td>
<td>.715</td>
</tr>
<tr>
<td><strong>Job Dissatisfaction</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Job, overall- this week√</td>
<td>.801</td>
<td>.800</td>
<td>.865</td>
<td>.870</td>
<td>.833</td>
<td>.813</td>
</tr>
<tr>
<td>Job, overall- last six months√</td>
<td>.783</td>
<td>.769</td>
<td>.821</td>
<td>.626</td>
<td>.572</td>
<td>.680</td>
</tr>
<tr>
<td>Kind of work -this week√</td>
<td>.769</td>
<td>.762</td>
<td>.662</td>
<td>.818</td>
<td>.814</td>
<td>.916</td>
</tr>
<tr>
<td>Kind of work -last six months√</td>
<td>.663</td>
<td>.675</td>
<td>.609</td>
<td>.612</td>
<td>.850</td>
<td>.877</td>
</tr>
<tr>
<td>Interaction coworkers - last six months</td>
<td>.657</td>
<td>.682</td>
<td>.575</td>
<td>.615</td>
<td>.477</td>
<td>.530</td>
</tr>
<tr>
<td><strong>Dissatisfaction with Organizational Change</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changes innovations implemented*</td>
<td>.873</td>
<td>.839</td>
<td>.845</td>
<td>.878</td>
<td>.834</td>
<td>.835</td>
</tr>
<tr>
<td>Amount/rate change</td>
<td>.859</td>
<td>.835</td>
<td>.840</td>
<td>.859</td>
<td>.823</td>
<td>.816</td>
</tr>
<tr>
<td>Opportunities for promotion</td>
<td>.770</td>
<td>.769</td>
<td>.750</td>
<td>.772</td>
<td>.806</td>
<td>.811</td>
</tr>
<tr>
<td>Pay and fringe benefits</td>
<td>.547</td>
<td>.571</td>
<td>.520</td>
<td>.533</td>
<td>.635</td>
<td>.652</td>
</tr>
<tr>
<td>Job security</td>
<td>.418</td>
<td>.458</td>
<td>.484</td>
<td>.410</td>
<td>.450</td>
<td>.450</td>
</tr>
</tbody>
</table>

If the structure that emerged from PCA was used, the following reliability for scales results were:

- **Dissatisfaction with Reward** last six months- for 4 items was Alpha = .650, and Site two Alpha = .651.
- **Job Dissatisfaction**- For this scale the Reliability Coefficients for 5 items was Alpha = .713, and Site two Alpha = .865.
- **Dissatisfaction with Organisations and Rewards** -For this scale the Reliability Coefficients for 5 items was Alpha = .719, and Site two Alpha = .786.
However, conceptually, these results were unsatisfying and the factors did not match the items. So the items were reconfigured into the structures noted below and the reliability coefficient for each new scale recalculated using:

1. This week Dissatisfied with your job, overall
2. Last six months Dissatisfied overall with your job
3. Last six months Dissatisfied with the kind of work you had to do
4. This week Dissatisfied with the kind of work you had to do
5. Last six months Dissatisfied with interaction with coworkers
6. *Work that you do is appropriate for the level if your current position*
7. *Dissatisfied with level of responsibility*

As can be observed, the inclusion of the two additional items increased the reliability coefficients; for 7 items for site one Alpha = .79 and for site two .84. This structure was then kept and renamed ‘Job Dissatisfaction’.

In the Reward Dissatisfaction Scale the reliability coefficients for 4 items for site one was .98 and for site two Alpha = .67, so that the following items were retained:

1. Overall you DID NOT feel adequately rewarded for your efforts at work
2. NOT satisfied are you with your opportunities for promotion
3. NOT satisfied are you with your pay and fringe benefits
4. NOT satisfied are you with your job security

The items for Dissatisfaction with Organisational Change were:

1. Dissatisfied are you with the way changes and innovations are implemented
2. Dissatisfied are you with the amount and rate of change within the organisation
3. Dissatisfied are you with the process used in ……… to assess your performance

The reliability coefficients for 3 items for site one was .53 and for site two Alpha = .82; the reliability coefficients for 2 items for site one was .52 and for site two Alpha = .82. Therefore only items 1 and 2 were used and ‘Dissatisfied with the process used to assess your performance’ to be used as a single item.

**DOMAIN –SPPCA**

**Group Nine: Self-perceived Performance Capacity and Adequacy and Related Satisfaction**

Factor analysis results for each data collection round using both transformed and untransformed data relating to the self-rated ability/performance items are listed in Table 6.9 below.
Table 6.9. Factor Analysis SPPCA and Related Satisfaction items using transformed & untransformed data (3 rounds)

<table>
<thead>
<tr>
<th></th>
<th>1 UT</th>
<th>1 T</th>
<th>2 UT</th>
<th>2 T</th>
<th>3 UT</th>
<th>3 T</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Self-perceived performance capacity and adequacy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POOR ability to concentrate</td>
<td>.928</td>
<td>.927</td>
<td>.909</td>
<td>.913</td>
<td>.877</td>
<td>.882</td>
</tr>
<tr>
<td>POOR ability to think clearly/focus thoughts</td>
<td>.881</td>
<td>.889</td>
<td>.895</td>
<td>.893</td>
<td>.886</td>
<td>.893</td>
</tr>
<tr>
<td>POOR ability to make decisions</td>
<td>.871</td>
<td>.870</td>
<td>.861</td>
<td>.874</td>
<td>.886</td>
<td>.887</td>
</tr>
<tr>
<td>POOR ability to problem solve</td>
<td>.767</td>
<td>.764</td>
<td>.793</td>
<td>.809</td>
<td>.801</td>
<td>.807</td>
</tr>
<tr>
<td>Dissatisfied with your own energy level</td>
<td>.756</td>
<td>.743</td>
<td>.705</td>
<td>.664</td>
<td>.655</td>
<td>.651</td>
</tr>
<tr>
<td>POOR overall work performance</td>
<td>.674</td>
<td>.682</td>
<td>.839</td>
<td>.844</td>
<td>.823</td>
<td>.841</td>
</tr>
<tr>
<td><strong>Dissatisfaction with own work performance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dissatisfied your own skills and abilities</td>
<td>.810</td>
<td>.798</td>
<td>.909</td>
<td>.906</td>
<td>.781</td>
<td>.805</td>
</tr>
<tr>
<td>NOT satisfied own work performance</td>
<td>.786</td>
<td>.768</td>
<td>.716</td>
<td>.731</td>
<td>.790</td>
<td>.758</td>
</tr>
</tbody>
</table>

The reliability coefficients were then calculated for the scales for each site using the grouping of the variables indicated above.

- **Self-perceived Performance Capacity and Adequacy** - for this scale the reliability coefficients for 6 items for site one was Alpha =.89, and Site two Alpha =.93. The reliability coefficients for Self-perceived Performance Capacity and Adequacy for 5 items rather than 6 and (when ‘Dissatisfied with your own energy level’ was removed) was for site one Alpha =.89, and Site two Alpha =.92.

- **Dissatisfaction with Work Performance** - for this scale the reliability coefficients for 2 items was Alpha =.20, and Site two was Alpha =.58. Whereas Dissatisfaction with Work Performance where 3 items (Dissatisfied were you with your own energy level added) the reliability coefficients for 3 items increased and for site one Alpha =.29 and Site two Alpha =.77.

**Individual items omitted from final analyses**

The following items were not included in any of the above scales because they failed to show clear patterns and or were already included in another form. However single items were be used as required as individual items:

- NOT satisfactory this week were your office space, furniture and layout drop
- Last six months you had more education than was required for your job
- Last six months received insufficient training
- Last six months work procedures not reasonable
• How often did you have to carefully follow standard operating procedures and
• Last six months conflict between you and your supervisor

DOMAIN FATIGUE

Psychological Fatigue – Wornout

As previously noted for this the ‘wornout’ scale of the GWBQ was used, with the items:

1. Have your feelings been hurt easily?
2. Have you got tired easily?
3. Have you become annoyed and irritated easily?
4. Has your thinking got mixed up when you have had to do things quickly?
5. Have you done things on impulse?
6. Have things tended to get on your nerves and wear you out
7. Has it been hard for you to make up your mind?
8. Have you got bored easily?
9. Have you been forgetful?
10. Have you had to clear your throat?
11. Has your face got flushed?
12. Have you had difficulty in falling or staying asleep?

For this scale the reliability coefficients for site one for 12 items was Alpha = .848 and for site two .768.

Physical Fatigue – Bodily Discomfort

Two constructs were included in this domain Upper and Lower Body Part Discomfort. Upper Body Discomfort was comprised of items related to discomfort to head; neck or shoulders; arms, mid back both sites and eyes in Site two only. For this scale the reliability coefficients for 5 items for site one was Alpha = .81 and for site two for 6 items was Alpha = .81. Lower Body Discomfort was comprised of items related to discomfort to the lower back and buttocks or legs. For this scale the reliability coefficients for 2 items for site one was Alpha = .58 and for site two - Alpha = .68.

DOMAIN – PSYCHOLOGICAL STRESS

Construct – SACL Stress

The Stress items were: Apprehensive, Bothered, Calm, Cheerful, Comfortable, Content, Dejected, Distressed, Jittery, Nervous, Pleasant, Peaceful, Relaxed, Restful, Tense, Uptight,
Uneasy, and Worried were used to calculate a score for Stress (Gotts and Cox, 1988). For this scale the reliability coefficient was for site one for 18 items was Alpha = .50 and for site two for 18 items was Alpha = .93. The reliability coefficient for this scale quoted by Gotts and Cox (1988) is Alpha .90.

**Construct– Arousal**

The arousal items were: Activate, Active, Alert, Drowsy, Energetic, Idle, Sleepy, Sluggish, Stimulated, Tired, Lively and Vigorous. For this scale reliability coefficients for site one 12 items was Alpha = .76 and. for site two the reliability coefficients for 12 items was Alpha = .86. The reliability coefficient for this scale quoted by Gotts and Cox (1988) is Alpha .88.

**FINAL CONSTRUCT PREPARATION PRIOR TO MULTIVARIATE ANALYSIS**

The final process was then to prepare the constructs for use in the various multivariate analyses. All the variables were assigned to a construct group using the process noted above. If a construct was to be used as an independent variable then to ensure that there was a ‘common metric’ for all variables both the transformed and untransformed variables within that construct were converted to Z scores. Then the ‘construct score’ was based on the average Z score of all variables within that group. If a ‘construct score’ was required for use as a dependent variable, the items were maintained in their original metric and the ‘construct score’ was based on the average of all variables within that group.

The following constructs were used in the multivariate analysis process described in the next chapters.

** Constructs: Personal and Non-work Variables Affecting Coping Capacity**

1. Age
2. Gender
3. Experience
4. Stress at home
5. Conflict between home and work demands and
6. Physical injury this week.

**WORK DEMANDS**

**Constructs: General Job Demands**

- Total Working Hours
- Too Much Work To Do In The Available Time (nine items)
- Time Pressures and Deadlines (six items)
- Responsibility (six items)
- Unpleasant Hours (two items)
- Workload Pressure (two items)
- Conflict this week (four items)

**Construct: Specific Work Demands**

- Static Physical Demands (three items)
- Cognitive Demands (three items)
- Dynamic Physical Demands (three items)
- Emotional Demands (four items)
- Important Consequences of Errors (one item)
- Demand for Care/Vigilance (five items)

**Construct: Contextual Demands and Impediments**

- Interruptions and Disruptions (six items)
- Environmental & Informational Impediments (six items)
- Performance Uncertainty (three items)
- Workload Variance (four items)
- Career Uncertainty (four items)
- Uncertainty about Work Requirements (five items)

**SUPPORT**

**Construct: Coworker relationships**

- Coworkers Support – this week (five items)
- General Coworker Support and Cohesive – last six months (five items)

**Constructs: Supervisor relationships**

- Supervisor Support this week (five items)
- General Supervisor Support last six months (five items)
- Senior Management Communications and Attitudes Score last six months (three items)

**CONTROL**

**Constructs: Job Control & Variety**

- Skill Utilization (four items)
of Variety (three items)
- Decision Latitude (four items)
- Influence (four items)

**Constructs: Sources of Work Related Satisfaction**

- Satisfaction with Reward last six months (four items)
- Satisfaction with Organisation and Change (two items)
- Dissatisfaction with Own Performance (two items)

**SPPCA**

- Self-perceived Performance Capacity and Adequacy (six items)

**ASPECTS OF WELLBEING**

- Worn-out Construct GWBQ (twelve items)
- Upper Body Part Discomfort (Site one 4 items Site two five items)
- Lower Body Part Discomfort (Site one and Two 2 items)
- SACL Stress (18 items)
- SACL Arousal (12 items)
- Job Satisfaction (four items)

The constructs developed from this process are superimposed upon a graphical representation of the JobLoad Model in Figure 6.1. Here blue indicates where a scale was developed for this purpose, red indicates use of an existing scale and green modification of an existing scale to suit the purposes of this study.

In this chapter the processes used to prepare the raw data for analysis were discussed. In Chapter 7, the results of the job analysis will be discussed then, in Chapter 8, the multivariate analysis processes that were used to examine the relationship between the variables of interest are detailed.
JOB CHARACTERISTICS
Factors affecting both work demands and individuals’ capacity or motivation to cope with demands
- Organizational context; Decision Latitude & Influence
- Work variety & Skill utilization;
- Unpleasant Hours & Education and skills required

WORK DEMANDS
Factors that people must cope with in performing their work; they demand the expenditure of effort

General and Temporal Work Demands
- Total Working Hours
- Too much work to do in the available time
- Time pressures and deadlines
- Responsibility
- Workload pressure

Specific Work Demands
- Demand for Care and Vigilance
- Cognitive demands
- Static physical demands
- Dynamic physical/risk demands
- Emotional demands
- Important consequences of errors

Contextual Demands & Impediments
- Interpersonal conflicts
- Interruptions & disruptions
- Environmental & informational impediments
- Performance uncertainty
- Workload variance
- Career uncertainty
- Uncertainty about work requirements

COPING CAPACITY
Factors affecting individual capacity to cope & motivation to exert effort

Personal and Non-work Variables
- Age; Gender
- Work experience
- Stress at home; Conflict between home and work demands
- Current physical injury

Other personal characteristics also affect coping capacity, but were not measured here.

Social & Management Support
- Coworker support
- General coworker support/ cohesion
- Supervisor support
- General supervisor support
- Senior management communications & perceived attitudes

Adverse Physical Environment
- Assessed using job analysis

PERFORMANCE ADEQUACY
Factors reflecting self-perceived performance capacity & adequacy, & satisfaction with performance
- Self-perceived performance capacity and adequacy
- Satisfaction with own performance

INDIVIDUAL WELLBEING
Dimensions measured: Physical Discomfort; GWBQ Wornout Scale; SACL Stress/Arousal; & Job Satisfaction

Figure 6.1. JobLoad Model and Measurement Instruments: blue = newly developed scales; red = pre-existing scales; green = modified scales; black = not directly measured
Chapter 7

DATA ANALYSIS APPROACH

DATA ANALYSIS APPROACH

The goal of this chapter is to describe the approach used to explore the relationships between the dependent and independent variables in the following results Chapters 9-15. The information gathering and data analysis occurred in several distinct substages (see Figure 7.1). After the literature review was completed, the job description process considered:

- Descriptive information about the organisational context, the physical work environment and general demands, skills requirements and team functions, as well as the personal and non-work factors (including demographic information) of employees at each site; and in addition

- How the level of task and job demands varied between the different job type and levels, and between the two sites (see chapter 8).

In the next stage, multivariate analyses were to be undertaken to explore the relationships between the selected job demands and factors and the aspects of wellbeing, which were of interest (Bodily Discomfort, Wornout, Arousal, Stress, Stress Hormones, and Job Satisfaction) and Self-perceived Performance Capacity and Adequacy.

However, the strategy adopted for this type of analyses was constrained by:

- the relatively small subject numbers in both sites (n=124 in site one, and n=56 in site two);

- differences in subject numbers between the sampling rounds (site one – round one n=120, round two n=103, and round three n=71; and for site two -round one n=56 and round two n=32); and

- the large number of Independent Variables (IVs) that were of interest.

The minimum recommended N:p ratio for z scores is 5:1 (Grimm & Yarnold, 1998; Norman & Streiner, 2001; Tabachnik & Fidell, 2001). Therefore to ensure that the analysis complied with this suggested ratio, the maximum numbers of IVs for any of the multiple regression analyses (MR) was set at 24 for site one and 11 for site two. However, this technique does not permit the inclusion of results from repeated measures, so linear mixed model (LMM) analysis was also used at both sites in order to consider the responses from subjects who participated more than

---

17 Of note is that in order to use a standard metric in all the domains except ‘personal and non-work variables the independent variables were transformed into z-scores.
once. This also permitted the researcher to compare the reliability of findings across two sites using two independent analysis techniques. The maximum number of IVs using linear mixed model (LMM) analysis with two repetitions for site one was 21; and site two seven; for site one LMM with three repetitions was 14 variables.

Linear Mixed Model analysis allows the use of data from repeated measures, including situations in which there are different numbers of repeated measurements or different intervals for different cases, or both (as is the case in the current study). It allows data that display correlation and non-constant variability. The possibility of using Structural Equation Modelling (SEM) was considered, but it was determined that the number of cases was too low for reliable use of this technique.

Figure 7.1 below displays the steps used to determine which IVs were included on the final stepwise multiple regressions for all round one data, and for the LMM with two and three data repetitions.
In order to ensure the N:p ratio was not exceeded, preliminary analysis was undertaken to identify for these samples which IVs were likely to be the most important predictors of each DV. The first step was to refer to the literature review, job description and bivariate correlations to note those factors, which were important. Where variables had significant bivariate correlations and later were found to have non-significant regression coefficients a post-hoc evaluation of the correlations using the Larzelere and Mulaik F test (1987) was undertaken. Where this revealed a significant F test this is reported.

An initial series of standard regression analyses and also linear mixed model analyses (with repetitions within rounds for the subset of participants who participated twice, and for the smaller subset who participated three times examining main effects only) were undertaken separately for each domain. That is, a separate MRC and LMM was performed for the factors within the following domains:

- Personal and non-work variables;
- General and Temporal Job Demands;
- Specific Demands;
- Job Control and Variety;
- Support;
- SPPCA;
- Sources of satisfaction; and
- Other aspects of wellbeing.

In the interests of brevity, the results of each preliminary data analysis for each DV is reported in the relevant Appendices (9-15) and only the final stage of analysis reported and discussed in each chapter. Inclusion of IVs in the final model was driven by a desire to examine how well the variables in the model account for the variance - so it's an hypothesis-driven approach to analysis not a simple exploratory one. The order of entry of variables into each regression model was always to include in the first block personal and non-work variables and then the work factors by sub domain. Non-significant factor in the sub domains were not included in the final analysis, except if there were no significant variables in the whole domain, in which case and an average score of all variables in that sub domain. This was done to maintain the coherence of the overall conceptual model. Occasionally non-significant variables were still retained (e.g. working hours), if there was a theoretical or literature-driven reasons for wanting to know about their effects.
Therefore, IVs were only included in the **final multivariate analysis models** if they:

- satisfied the requirements of the conceptual framework (for example to account for the effect of personal and non-work variables on the DV or the effect of job level on ratings), or
- were required to answer a question arising from the literature or the JobLoad Model (for example the relationship between the DV and working hours); or
- had been identified through the initial screening process as a potentially significant predictor.

So in the final stage of data analysis, the task and job-related IVs within each domain that were most strongly related to the DV, based on bivariate correlations, regression coefficients and estimates of fixed effects (reported above), were then included together in a sequential multiple regression analysis (round one data) and linear mixed model analyses (two and three repetitions).

In the **sequential regressions** significant variables were entered stepwise in seven blocks in the following order:

- Block one - personal & non-work factors,
- Block two - the significant general and temporal job demands;
- Block three – specific work demands:
  - Block four – job control & variety
  - Block five – support; and
  - Block six – contextual demands & impediments;
- Block seven - SPPCA.

Where it was considered relevant sometimes the following two blocks were also used:

- Block eight – satisfaction:
- Block nine - other aspects of wellbeing.

However the LMM allowed all significant variables to be entered concurrently, although to comply with the N:p ratio of 5:1 the number of IVs permissible was limited. To maintain an acceptable ratio of cases to variables, only significant variables from the most centrally important domains were included in final **linear mixed** model (LMM) analyses. With three repetitions, fewer variables were permitted so those with non-significant relationships were generally omitted. In all final model analyses tables, statistically significant relationships with probability of chance occurrence < .05 are highlighted in red and those between .05 and .1 are highlighted in blue.
While many aspects of the job demands between the two sites were similar, the differences (for example in site two there was only one job type – clerical) meant each site needed to be analysed separately. However, in order to facilitate comparisons and discussion, the results from both sites were combined into a single table at the end of each chapter.
PART 3: RESULTS AND DISCUSSION

Job Description, Bodily Discomfort, Wornout, Stress, Arousal, Job Satisfaction, SPPCA and Stress Hormones
Chapter 8

JOB DESCRIPTION

Prior to the commencement of data analysis using the JobLoad Index, information about the job roles, work demands and factors was gathered by:

• Reviewing the ‘Strategic Plans’ and Annual Reports;
• Conducting Ergonomic Workplace Assessments of the physical working environments (the researcher is a Certified Professional Ergonomist) which considered the lighting and thermal conditions, workstation layouts, equipment and tools, and manual handling requirements.
• Conducting semi-structured interviews and focus groups with subsets of employees and supervisors to determine the;
  o Team role and usual tasks,
  o Psychosocial and physical environmental demands, and
  o Job and organisational factors which were likely to influence overall work demands.

This chapter reports the main information collected during this process, which will be called the ‘Job Description’. In the interests of brevity, the results of this process are outlined at Appendix 8, and only the key findings are presented here.

BACKGROUND INFORMATION AND DEMOGRAPHICS

In order to maintain the anonymity both of the organization and the subjects, specific details about the role and responsibilities collected during the Job Description process have been deliberately omitted. What follows is a synopsis of the major background issues, roles, work demands, and other pertinent issues, with identifying information removed.

Organizational Context

The first site was a branch of a large organisation, where subjects were primarily engaged in the design, development, implementation, adaptation, support, management and/or servicing of computer-based and telecommunications systems. The second site was a smaller organisation, which provided policy advice to other government departments, employers, and trade unions. In both sites organisational changes had and were occurring over the data collection period. Specific questions were developed and included in the JobLoad Index to capture the main issues.

18 to maintaining confidentiality, these have not been included
Staff Reductions

In site one, the branch had undergone significant staff reduction over the last three years, decreasing in size by 50%. In site two the office had relocated from another city in the previous year with only 5% of the original staff retained. At both sites some loss of corporate knowledge had occurred. In both sites the questions relating to ‘over the last six months’ were designed in part to capture the impact of ongoing changes.

In site one, members of the focus group had raised concerns about the amount of organisational change, performance appraisal processes, and staff reductions. Questions relating to satisfaction with ‘staffing levels’, ‘the amount and rate of change’ and ‘the way changes and innovations are implemented’ were included in the JLI.

Both sites had recently moved to new financial and other management systems. Three questions were devised to capture the adequacy and satisfaction with training to deal with these new demands. In both sites most staff worked in small groups of up to 6 staff, managed by team leaders and led by directors. The requirement to supervise and manage staff, and responsibility for resources management and delivery of outputs increased with the level of seniority. In site one the official standard hours were 37.21 hour per week with some requirement to work shifts and undertake overtime. In site two, no shift work was required, the official standard working hours were 37.50 hours per week.

Employment Arrangements

In site one the majority of staff (76%) were employed as ‘full time employees’ followed by ‘full time contractors’ (24%) and only a small number as ‘part time contractors’ (1%). However, subjects reported that as the pressure to ‘outsource’ activities the proportion of people on contracts was increasing. In site two, all but two of the subjects were full time employees, and only two of the subjects were known to be working under contracts.

Job Demands and Skills Requirements

Literacy and Numeracy

All subjects required a high levels of oral and written literacy in English, basic numeracy and good computer skills. Officers performing statistical, accounting, and requisitioning tasks required higher numerical skills. In site one all staff needed ‘high security’ clearance.
Sensory Capacities

All subjects were required to visually discriminate text on paper or screens. In the technical areas, the ability to discriminate colour and shape was critical to effective performance.

Physical Capacities

The capacity to undertake manual handling tasks and precision manipulation of instruments was important for the Technical Officers in site one. No individuals with physical disabilities (that limited their capacity to handle loads) were employed in those teams. There were high levels of disabled person access.

Physical Environment

All staff usually worked in air-conditioned buildings with spacious well-equipped office cubicles or sometimes (in site one) at technical workstations. Both building had excellent staff amenities. Lighting levels were assessed as appropriate for the work circumstances and the thermal range for most subjects generally acceptable.

Participant Information

In site one, a total of one hundred and twenty (120) employees participated in one or more of the three data collection rounds, with two hundred and ninety four (294) survey responses collected over the three rounds (see Appendix 8, Table 8.1). It was estimated that approximately 63% of the staff participated in the study and of these 62.1% providing valid urine samples. As expected in a longitudinal study, there was some loss of subjects during the course of the study, due to subjects leaving the department, being ‘too busy’, or responses returned after the cut-off. Some staff who were ‘too busy’ to participate in round two were able to participate again in round three.

It was considered prudent to check that those subjects who only complete one round of the study were not substantially different from those who chose to complete more than one round. Analysis of these scores showed not significant differences.

In site two a total of fifty-five (55) employees participated in one or more of the two data collection rounds with eighty-eight (88) survey responses collected over the two rounds. The number of staff from both offices combined (allowing for staff on leave or temporary transfer) was approximately seventy-five, so approximately 73% of all staff participated (see Appendix 8, Table 8.2). As the respondents had requested anonymity, it was not possible to follow up subjects who completed the first round but failed to do so for the second round.
Gender

Subjects’ gender was of interest as it might relate to the type of job and related work demands. Few women were employed in the technical areas and proportionately more within the clerical areas. In site one, 71% of subjects were male and 29% female. However, female participants were actively recruited to ensure that the sample was as representative as possible for issues that may be related to gender. The success in this recruitment process means that the female/male ratio in the sample was slightly higher than the true gender ratio at the branch.

In site two, 50% of the subjects were males, 35% female, and 15% the gender was unknown. For the whole population of this organization, the gender ratios are actually about equal, so the sample probably slightly under represented females. At both sites, there were proportionally more male staff at the more senior levels.

Age

In site one, the average age of subjects was 41 years (SD 9.2 years). At site two, at the request of subjects this information was not collected. However, the annual report noted that most staff was over 35 years of age. At both sites, higher proportions of senior staff were in the older age groups.

Education

In site one, 54% of staff had some form of post school qualifications, reflecting the specialist nature of the work undertaken (see Appendix 8, Table 8.3). This information was not formally collected in site two. However, the nature of the work undertaken by this organization meant that most subjects had at least tertiary and many postgraduate education.

Experience

In site one, the mean ‘length of time in current job’ was 3.3 years (SD 4.0), whereas for site two the mean was 1.9 years (SD 1.9) reflecting the mass recruitment (95% new staff) that occurred with the organizations’ relocation to Canberra in the previous two years. For site one, the mean ‘length of time at current job level’ was 4.4 years (SD 4.0) and at site two 2.8 years (SD 2.8).

Home Demands

In site one, just over 61%, and in site two, 58% of participants had one or more children less than 18 years of age living at home. In site one 24%, and 19% in site two of subjects reported there was stress at home. At site one 26% and at site two 27% of participants reported conflict between home and work demands.
General Health

General health status influences coping capacity, so using a 7-point rating scale (from extremely poor to extremely good), participants were asked to rate their general health that week. The mean for ‘General Health’ at site one was 5 (SD 1.5) with a mode of 6, and for site two 3.2 (SD 1.5) with a mode of 2.

Subjects were also asked if they were experiencing a physical injury or illness which impacted on their work performance that week, only 13% of site one and 12.7% of site two participants reported that they were. Given all responses were received from those who were well enough to attend work the same was expected to reflect those with better physical and psychological health.

Job Type

Subjects were classified as belonging to one of four groups:

- Clerical Officers (n = 33 site one; n = 55 in site two);
- Information Technology Officers (n=38);
- Technical Officers (n = 34); and
- Communications and Help Desk Officers (n = 15).

Clerical Officers

At both sites, the Clerical Officers’ role was to provide financial, file management and records management, administrative advice and undertake policy development. Most staff had degrees or higher tertiary qualifications. All staff required basic computer and other general office skills. The general physical demands were for long periods of sitting working at computer terminals. If these staff performed well they had opportunities to go on overseas postings. The emotional demands were low in site one but higher in site two where staff at times dealt with complicated relationships with the organisation’s clients.

Information Technology Officers

In site one these officers developed and coordinate delivery of IT services and support; some provided technical IT support. Others designed and oversaw the installation (by technicians) of complex IT hardware. The required education was mostly at degree level (or higher) and for extensive relevant experience. The general physical demands were for long periods of sitting at computer terminals with no manual handling. The general mental demands were for rapid complex decision-making with significant pressure to deliver outcomes on time. The emotional demands were reported moderate, and these officers had high status and financial rewards.
Technical Officers

In site one these officers constructed (under direction of engineers), installed, and maintained electronic equipment and circuitry. They also maintained and operated the computer mainframes. The required education was for a trade certificate. There was a mix of duties: some teams performed highly routine and often boring work, with minimal opportunities to move to other sections; and others had more interesting work and undertaking technically complex activities. Work sometimes involved overseas travel. The general physical demands were for periods of intense fine motor activity, reaching, sitting, standing, and occasional manual handling of heavy loads (up to 60 kilograms). Work was occasional carried out in confined spaces, and in noisy and hot environments.

The general mental demands were for rapid decision-making interspersed with periods of monotony but with the need for vigilance. The consequences of errors were reported as high as the work was essential to effective worldwide operation of the organization. Some groups provided 24 hours seven days per week service. Officers occasionally needed to work up to 12-14 hours per day for short periods. The focus group reported that overseas travel was required and this carried pressures associated with being away from families. Staff travelled overseas usually also undertook “safe hands secure transfer” of expensive and highly sensitive communications equipment. Members of the focus groups reported this was enjoyable work and that travel was usually viewed positively as the allowances were generous. Technical Officers reportedly became so highly skilled they were able to easily able to get employment outside the agency but perhaps not at the same pay level. They had high status, and for subject with this education level, above average economic rewards.

Communications and Help Desk Officers

In site one these officers provided secure national telecommunications and radio communication and messaging. They analysed incoming information for security issues. A small number of staff also provided communications and IT ‘help desk’ services. While there was no recognized certification associated with the work, the skill level for the analysts was high – with up to 12 months ‘on the job training’ and very high security clearance. Their role was considered so critical that there was some ‘shadowing’ of staff to ensure critical services were maintained if a staff member left.

The general physical demands were for work to be carried out in a highly secure location with few windows. Work was carried out sitting at a computer workstation with multiple (up to 3) screens, with few opportunities for spontaneous breaks. All team members undertook shift work
providing a 24 hours 7 days per week service. Most staff was rostered to be ‘on call’ every 2 weeks. The focus group revealed that there had been significant technological change occurring within the area not all of which were regarded positively.

The general mental demands were for periods of highly monotonous work and routine work with the need for vigilance. Staff complained that the current staffing level left little ‘spare capacity’ for dealing with peaks in workload. As a result, this area was experiencing chronic staff shortages and difficult recruiting new officers. The area was reported to be down 50% on staffing levels from the previous 12 months.

Subjects providing help desk services reported experiencing stress associated with call queuing and dealing with unhappy clients. The focus group revealed resentment about the performance appraisal system, pay and a ‘lack of appreciation’ by others of their work.

**Job Level**

Job Level was expected to relate to some types of demands (e.g. responsibility) but also to the level of control. Due to small numbers of subjects job levels three and four were combined. In site one; there were four different job levels:

- **Job Level One** [Australian Public Service Level 1-4, Technical Officers Grade 1-2, Information Technology Officer Grade 1 (n=39)];
- **Job Level Two** [Australian Public Service Level 5-6, Technical Officers Grade 3-4, Information Technology Officer Grade 2 (n=39)];
- **Job Level Three-four** [Executive Officer Level 1, Senior Officer Grade C; Executive Officer Level 2, Senior Officer Grade A/B, Director (n=28)]; and
- **Job Level Five** [contractors where the level was unknown (n=14)].

In site two, to ensure the anonymity of the relatively small number of participants, it was agreed that there would be only three job levels recorded:

- **Job Level One** [Australian Public Service Officers Levels 1-6-(n=26)];
- **Job Level Two** [Executive Level 1 Officers (n=13)]; and
- **Job Level Three** [Executive Level 2 Officers and Senior Executive Service Officers (n=12)].

**WORK DEMANDS AND JOB FACTORS**

The Job Description process considered the organizational context of each site, the roles, required skills, and abilities, physical working environments, job characteristics, general work demands,
support as well as the demographic profile of each site. Ratings derived from the JLI also provide information about work demands (general and temporal demands, specific demands, contextual demands, and impediments) job factors, satisfaction and other aspects of wellbeing and demographic information. Factors which were not expected to vary such as responsibility were only over the last six months. So the rating reflected the person’s estimation of the demands of all their work not just specific work tasks. Before analysis commented it was of interest to determine if the ratings reflected an average working week, the majority of staff (80%) in both sites reported that the collection week was a ‘normal’ week.

For each construct, their full details including means, SDs and subjects numbers for each data collection rounds and for both sites are listed in Appendix 6.3., Table 6.1. The Work Demand and Factors were arranged in six domains these were:

1. General & Temporal Demands Items (7 constructs);
2. Specific Work Demands (6 constructs);
3. Contextual Demands & Impediments (7 constructs);
4. Job Control and Variety (4 constructs);
5. Supports (5 constructs);
6. Satisfaction (3 constructs);
7. SPPCA; and
8. Aspect of Wellbeing (nine constructs).

Prior to the multivariate analysis, univariate analysis was undertaken to establish how ratings for each of the above construct, at each site, varied between rounds, different Job Types and Levels. One-way ANOVAs were undertaken and where there were significant, post hoc tests carried out. Table 8.1 summarises where significant differences using the post hoc tests for each factor between the two sites, job types, and levels. In the interests of brevity, these are reported in full in Appendix 8.
Table 8.1. Overview of significant relationships between construct measures, Job Type (both Sites together), and Job Level for Sites One and Two separately.

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Job Type Both sites</th>
<th>Job Level Site One</th>
<th>Job Level Site Two</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WORK DEMANDS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General &amp; Temporal Job Demands</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Hours Worked</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Time Pressure and Deadlines</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Too Much To Do In The Available Time</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Unpleasant Working Hours</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Increasing Workload Pressure</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Responsibility</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Specific Work Demands</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Static Physical Demands</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Cognitive Demands</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Dynamic Physical Demands and Risk</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Demand for Care &amp; Vigilance</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Emotional Demands</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Errors have important consequences</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Contextual Demands &amp; Impediments</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interruptions and disruptions</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Environmental and Informational Impediments</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Uncertain About Work Requirements</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Performance Uncertainty</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Workload Variance</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Career Uncertainty</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Conflict this week</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>
Table 8.1 Significant Differences between Sites, Job Types and Levels (continued)

<table>
<thead>
<tr>
<th>JOB FACTORS</th>
<th>Job Type Both sites</th>
<th>Job Level Site One</th>
<th>Job Level Site Two</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Job Control &amp; Variety</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skill Utilization</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Work Variety</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Decision Latitude</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Influence</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Supports</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coworkers Support</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Coworkers Cohesion and Relationships</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Supervisor Support this week</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>General level Supervisor Support</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Senior Management Attitudes and Communication</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Satisfaction factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reward Satisfaction</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Satisfaction with Organizational Change</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Satisfaction with Own Performance</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Satisfied with Performance Appraisal Process</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>SPPCA</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>ASPECTS OF WELLBEING</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UBPD</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>LBPD</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Wornout</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Stress</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Adrenaline</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Noradrenaline</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Cortisol</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Arousal</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Job Satisfaction</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

There were significant differences detected between the job types and levels at both sites for Total Hours Worked. The highest of these values were from the Technical Officers largely derived by those working long hours when travelling overseas on short-term missions and then for IT Officers who were engaged in program rollouts, at both sites the most senior staff also reported working longer. While only Total Hours Worked was used in the final analysis it is noted that unsurprisingly the mean Working Hours was much lower. This difference is
noteworthy as often ‘extra’ working hours, such as those conducted at home, on weekends are invisible (at least for official purposes) and especially and issue as employees move to job levels where they are not required to complete time sheets. Clearly documenting ‘actual’ working hours gives a more accurate estimate of the number and type of staff required to resource projects adequately. There is a strong argument that chronic underestimation of real working hours simply reinforces the expectation that staff have ‘a performance problem’ if they are unable to complete the work within standard hours. Even when acknowledged, senior staff may view this situation as ‘just part of the way you have to work at my level’.

This finding is consistent and with other studies on working time in where a third of Australians are working significantly longer hours than the standard work week, and when compared with other OECD countries Australia now has more people working more hours than all other member countries except the US (see Qld DIR, 2001; ABS 2003). The pattern of increasing working hours reflected both in this study and others is of concern due to the potentially negative effects on employee health if working hours consistently exceed 55 hours per week (Åkerstedt & Torbjörn, 1996).

Significant differences were also detected but only between the job levels at site one for the other general and temporal job demands (see Appendix 8). Overall, the more senior staff reported having significantly higher demands, and while there were also differences in site two these did not reach significance.

With regard to the specific work demands differences between the job types noted for the factors static physical demands, demand for care and vigilance and errors have important consequences. The highest ratings for demands for care and static work were for the Communications and Help Desk Officers who were required to monitor information on screens for accuracy and compliance with security procedures. Errors were rated as most important by the Technical Officers whose tasks were objectively rated by the researcher as critical to the organization’s mission. At both sites, significant differences were detected between the job levels for the static physical demands, which were highest for the more junior staff, whereas the cognitive and emotional demands and consequences of errors were highest for the more senior subjects.

Differences emerged between the job types for those factors relating to contextual demands and impediments. The Technical Officers who were required to work in situations with low supervision reported the highest levels of uncertainty about their work requirements but it was the Communications Officers whose were experiencing restructuring and downsizing which

19 Australian Labour Force Statistics 2003 Labour Feature Article - Technical report: Measures of weekly hours worked
reported the highest levels of career uncertainty and workplace conflict. While at both sites differences were detected between the job levels for factors in this domain, the factors which were considered important varied. In site one, the more senior officers had more frequent interruptions and disruptions, whereas junior staff had the more career uncertainty and contractors the most workload variance. In site two, it was interesting that it was the most senior staff who reported the highest levels of uncertainty and conflict.

With regard to the job control and variety factors the Clerical Officers had the highest decision latitude, whereas the Technical Officers had the highest influence within their organisation. While no differences between the job levels were apparent for site two, there were at site one, with the most senior officers reporting the highest levels of decision latitude, influence, variety and skill utilisation. Support was generally quite high amongst all the job types and levels, but supervisor support was rated as quite poor by the Communications and Help Desk Officers, and by the most senior subjects.

While overall, the ratings were quite high there were differences both between the job types and levels with regard to satisfaction with rewards for effort, with the Technical Officers having the highest ratings. It was of note that this group was highly valued by the organization, especially given at the time of the study there was an acute shortage of suitably qualified and security-cleared officers. These officers’ pay rates were much higher (than comparable jobs in other workplaces) due to the ‘loadings’ for undertaking overseas missions and for weekend work. This group also received additional ‘fringe benefits’ such as informal paid time off (to recover after returning from overseas missions), and taxis to and from work whenever they were working nightshift on the weekends. Most job levels had similar satisfaction ratings with the significant difference driven by the relatively lower satisfaction ratings from the most junior officers.

For the outcome factors, significant differences were detected between SPPCA between the job levels, with the contractors reporting the overall highest scores. For bodily discomfort using both UBPD and LBPD the highest ratings were found for those at job level two. The Technical Officers and the most junior officers at site one had the highest Wornout scores. Stress was highest amongst the Clerical Officers at site one, but no significant differences between the job levels were detected. Arousal and Job Satisfaction scores were highest for the IT Officers and the contractors in site one.

While neither job type, nor job level was included in the multivariate analysis, following each regression analysis, job type was added in as a last block (in site one) and job type in both sites to determine if they did indeed contribute to the variance explained. However, using this approach,
both job type and level, when added after all other job demands (which of course reflect the key components of a job or level) were added very little to the variance explained and in any case were never statistically significant.

CONCLUSIONS

The Job Description process (much of which is described more completely in Appendix 8) provided objective and subjective information about the organisational context, work demands, and a range of other workplace factors. This information was used to clarify relationships in the subsequent multivariate analysis, as such this process was viewed as a valuable part of the process of triangulating results.

So despite all the subjects being Australian Commonwealth Public Servants, the profile of each organisation was slightly different, in part because at site one, subjects undertook a mix of clerical, IT, technical and communications duties, whereas at site two, all subjects were essentially clerical officers. As will be shown, this did limit the ability to compare the multivariate analysis results between the sites. There were surprisingly high similarities amongst ratings of work demands between the two groups of clerical officers, and where differences were apparent these appeared to relate to the organisational level factors.

From the results above, it can be seen that overall, there were more differences between the job levels rather than between the job types. However as all subjects were employed within a white collar type environments it might be expected that more differences would become apparent if comparisons had been made for example with the demands of manufacturing or construction jobs.
This chapter reports relationships between various dimensions of JobLoad and subjects’ Upper Body Part Discomfort (UBPD). Body Part Discomfort scores were developed based on those of Corlett and colleagues (Corlett, 1976; Corlett & Bishop, 1992). A six point scale (0 = no discomfort to 5 = extreme discomfort) was used to obtain ratings for the body regions: ‘head’, ‘neck and shoulders’, ‘arms’, ‘mid back’, ‘low back’ and ‘buttocks and legs’ and also for ‘eyes’ in site two.

Toomingas et al. (1997) observed that averaging scores from different body parts can hide true associations with work factors (which then impedes effective prevention). However, this study focused on the role of workload as a contributor to overall bodily discomfort, so combining ratings from different body regions was acceptable. Further, exploratory examination of the bivariate correlations between scores for each separate body region with each IV, showed few significant associations (see following section, and Appendix 9). It was therefore decided to group scores simply into two categories: upper body and lower body discomfort. This differentiation was retained because some authors have found that different factors predict upper versus lower body part discomfort (Hagberg et al., 1995; NIOSH, 1997).

Scores for UBPD were created by adding those for the head, neck/shoulders, arms, and mid-back, resulting in a 20-point scale\(^{20}\). Collection and analysis of data at site two occurred later and here the Job Description identified that eye discomfort was an issue so a rating for ‘eye discomfort’ was also included, creating a twenty five point range. For ease of comparison in the multivariate analysis, the scores between the sites were harmonised so the range was the same at both sites (0-5).

The scores for Lower Body Part Discomfort (LBPD) were created by adding ratings for the ‘low back’ with those for ‘buttocks and legs’, resulting in a 10-point scale.\(^{21}\) However, given the type of work undertaken at both sites the focus of interest was on how workplace factors influenced levels of UBPD. For the sake of thoroughness, these were also analysed, but as expected, both the levels of LBPD and the number of significant relationship were small. In the interests of brevity, results relating to LBPD are included in Appendix 9, and will not be discussed further.

---

\(^{20}\) not counting 0; Reliability coefficient site one (5 items) \(\alpha = .815\) and site two (6 items) \(\alpha = .815\)

\(^{21}\) Reliability coefficient site one \(\alpha = .587\) and site two for \(\alpha = .687\)
In the first section of this Chapter the UBPD results are presented for site one, followed by those for site two. In the second section a review and discussion of the results at both sites occurs.

**UBPD RESULTS: SITE ONE**

Figure 9.1 shows mean ratings for the ‘head’ (μ =1.7, SD=1.5), ‘neck/shoulders’ (μ=2.0, SD=1.6), ‘arms’ (μ =1.2, SD=1.4), and ‘mid back’ (μ=1.2, SD=1.4). Typically, the regions with the greatest discomfort were the neck/shoulders and head.

![Bar graph of ratings of UBPD for separate body regions (Site One)](image)

The overall UPBD mean (using the 5 point scale), was 1.5, SD 1.2 and the distribution of the scores were strongly positively skewed, as most subjects reported little or no discomfort (see Figure 9.2). However, rather than transform the data the alternative approach recommended by Tabachnick and Fidell (2001) was adopted, whereby residuals were screened following regression analysis, to detect differences between predicted and actual values. As these appeared close to a normal distribution no transformation was performed (see Appendix 9). Retention of data in the original metric also facilitated subsequent interpretation of results.

A one-way ANOVA confirmed no statistical difference between UBPD scores over the three rounds.
IDENTIFICATION OF FACTORS INFLUENCING UBPD

Preliminary Analyses

Bivariate correlations between UBPD and other measured constructs, grouped into the major domains identified by the JLM, are shown in Table 9.1 of Appendix 9. The results of the preliminary multivariate analyses using MR and LMM as previously described are reported in Appendix 9.

Variables with bivariate correlations over 0.3 or higher for at least one survey round, or which were statistically significant for at least two of the rounds, or were found to be significant in the multivariate analyses included:

- two of the six General and Temporal Demands: *time pressure and deadlines*, and *unpleasant working hours*
- one of the eight Physical Task Demands items: *awkward arm and body positions*
- three of the Non-physical Demands items: *demand for care and vigilance*, *emotional demands* and *errors important consequences*
- one of the seven Contextual Demands and Impediments: *conflict*
- two of the four Job Control and Variety: *decision latitude, influence*
- one of the five Support factors: *supervisor support*
SPPCA
- two of the Personal and Non-work variables: age and general health

MULTIVARIATE ANALYSES

The strategy adopted for multivariate analyses has been previously described (see Chapter 8). The only difference was that here, because of the more specific relationships expected between bodily discomfort and aspects of physical demand, the items within the static physical demand and dynamic physical demand constructs were analysed as separate variables. Results of the initial analysis stages are reported in Appendix 9. Based on these results, along with evidence from published research, the factors within each domain that were most strongly related to physical discomfort scores were identified, and used in the final multivariate analyses. However, the variable physical injury this week was excluded, despite its significant correlation with discomfort, because this was viewed simply as an alternative indicator of bodily discomfort.

Standard multiple regression (MR) analysis was used for round one data only, to encompass all participants in the study. In addition, linear mixed model (LMM) analysis with repetitions within subjects over either two or three rounds were used for the subset of participants who participated twice, and for the smaller subset who participated three times.

**Stepwise Sequential multiple regression analysis (round one data)**

Results of the sequential multiple regressions (MR) are summarised below and in Tables 9.1 and 9.2.:

- **Block one – Personal & Non-Work Factors:** $R^2 = .071$, ($F_{[2, 116]} = 4.458$, $p < .01$). Two factors – age and poor general health – were entered, and found to explain 7.1% of the variance in UBPD scores.
- **Block two – General and Temporal Work Demands:** $R^2 = .077$, ($F_{[4, 114]} = 2.255$, $p = .056$). No individual factor in the preliminary analysis explained a substantial amount of variance, Therefore an average of all factors except two within this domain was used; factors excluded from the average were total working hours, which are treated separately, and responsibility since, unlike the other factors, there was no clear hypothesis concerning the direction of any effect that it might have on discomfort. Accordingly, the variables used here were general and temporal demands score (Z score), and total working hours (Z score). Together they accounted for very little variance in discomfort.
- **Block three – Physical Work Demands:** $R^2 = .208$, ($F_{[12, 106]} = 2.284$, $p < .01$). Eight factors were entered: work very hard (Z score) precise accurate movements (Z score), long
periods of sitting and standing in same position (Z score), repetitive work (Z score), awkward body or arm positions (Z score), forceful movements and actions (Z score), walk fast (Z score), and exposed to risk of injury or illness (Z score). These factors explained 13.2% of the variance in UBPD score.

- Block four – Non-physical Work Demands: $R^2 = .286$, ($F_{[16, 102]} = 2.524$, $p < .01$). Four factors were entered cognitive demands (Z score), demand for care and vigilance (Z score), emotional demands (Z score), and errors have important consequences (Z score). These explained 7.7% of the variance in UBPD scores.

- Block five - Contextual Demands & Impediments: $R^2 = .308$, ($F_{[17, 102]} = 2.610$, $p < .01$). One factor was entered, conflict (Z score), this explained 2.2% of the variance.

- Block six - Job Control and Variety: $R^2 = .308$, ($F_{[18, 100]} = 2.451$, $p < .01$). In the preliminary analysis, no individual factor explained a substantial amount of variance, so an average of all factors – job control score (Z score) – was used. It explained no additional variance.

- Block seven - Support: $R^2 = .311$, ($F_{[19, 99]} = 2.330$, $p < .01$). No individual factor in the preliminary analysis explained a substantial amount of variance, so an average of all factors support score (Z score) was entered; it explained no additional variance.

- Block eight - SPPCA: $R^2 = .365$, ($F_{[20, 98]} = 2.703$, $p < .01$). SPPCA was entered as a single factor, and it accounted for 5.4% of additional variance in UBPD score.

Table 9.1 shows that the F-changes between blocks in the above sequence were significant (in red) at the first, third, fourth and eighth block.

<table>
<thead>
<tr>
<th>Block</th>
<th>R Square</th>
<th>R Square Change</th>
<th>F-change</th>
<th>Sig. F-change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Personal &amp; Non-Work factors</td>
<td>.071</td>
<td>.071</td>
<td>4.458</td>
<td>.014</td>
</tr>
<tr>
<td>2 – General &amp; Temporal Work Demands</td>
<td>.077</td>
<td>.005</td>
<td>.338</td>
<td>.714</td>
</tr>
<tr>
<td>3 - Physical Work Demands</td>
<td>.208</td>
<td>.132</td>
<td>2.201</td>
<td>.033</td>
</tr>
<tr>
<td>4 - Non-physical Work Demands</td>
<td>.286</td>
<td>.077</td>
<td>2.761</td>
<td>.032</td>
</tr>
<tr>
<td>5 - Contextual Demands &amp; Impediments</td>
<td>.308</td>
<td>.022</td>
<td>3.280</td>
<td>.073</td>
</tr>
<tr>
<td>6 - Job Control &amp; Variety</td>
<td>.308</td>
<td>.000</td>
<td>.002</td>
<td>.965</td>
</tr>
<tr>
<td>7 - Support factors</td>
<td>.311</td>
<td>.003</td>
<td>.369</td>
<td>.545</td>
</tr>
<tr>
<td>8 - SPPCA</td>
<td>.365</td>
<td>.054</td>
<td>8.333</td>
<td>.005</td>
</tr>
</tbody>
</table>

Table 9.2 below, shows the unstandardized regression coefficients (B) and intercept, the standardized regression coefficient ($\hat{\beta}$), the semipartial correlation coefficients ($sr_2^2$) and $R^2$, and adjusted $R^2$ values for the final model.
With this combination of variables, age, general and temporal demands, demand for care and vigilance, emotional demands and self-perceived performance capacity and adequacy (in red) differed significantly from zero. Their unique contribution to the $R^2$ was .182 and the other IVs in combination contributed another .183 in shared variability. Several factors (in blue) had significance levels between .05 and 0.1 including: work hard, errors have important consequences and conflict.

A total of 36.5% (23.5% adjusted) of the variability in UBPD scores were predicted by these IVs. It is likely that the different cuts of the data (MR used only round one data whereas LMM used data where people did the JLI twice and three times) resulted in variations in the factors which were significant. Examination of the bivariate correlations for example, shows higher scores for the second and third data collection rounds. But for both data analysis processes the direction of the regression coefficients were the same.

Table 9.2. Results of Sequential Multiple Regression of UBPD (round 1 site one)

<table>
<thead>
<tr>
<th>Variables</th>
<th>B (%)</th>
<th>SE</th>
<th>B</th>
<th>Sig.</th>
<th>sri2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>-1.102 (0.5)</td>
<td>.046</td>
<td>-.201</td>
<td>.028</td>
<td>-.179</td>
</tr>
<tr>
<td>General state of health</td>
<td>.170 (0.8)</td>
<td>.348</td>
<td>.051</td>
<td>.626</td>
<td>.039</td>
</tr>
<tr>
<td>Total Hours Worked</td>
<td>-.658 (3.2)</td>
<td>.420</td>
<td>-.151</td>
<td>.121</td>
<td>-.126</td>
</tr>
<tr>
<td>General and Temporal Demands</td>
<td>1.37 (6.8)</td>
<td>.653</td>
<td>.269</td>
<td>.038</td>
<td>.170</td>
</tr>
<tr>
<td>Work hard</td>
<td>1.19 (5.9)</td>
<td>.627</td>
<td>.238</td>
<td>.060</td>
<td>.153</td>
</tr>
<tr>
<td>Precise accurate</td>
<td>-.269 (1.3)</td>
<td>.496</td>
<td>-.060</td>
<td>.589</td>
<td>-.044</td>
</tr>
<tr>
<td>Long periods of sitting and standing</td>
<td>-.127 (0.6)</td>
<td>.499</td>
<td>-.029</td>
<td>.800</td>
<td>-.020</td>
</tr>
<tr>
<td>Repetitive work</td>
<td>-.266 (1.3)</td>
<td>.526</td>
<td>-.058</td>
<td>.614</td>
<td>-.041</td>
</tr>
<tr>
<td>Awkward arm and body positions</td>
<td>.828 (4.1)</td>
<td>.515</td>
<td>.178</td>
<td>.111</td>
<td>.130</td>
</tr>
<tr>
<td>Forceful movements</td>
<td>-.593 (2.9)</td>
<td>.481</td>
<td>-.128</td>
<td>.220</td>
<td>-.099</td>
</tr>
<tr>
<td>Walk fast pace</td>
<td>-.432 (2.1)</td>
<td>.484</td>
<td>-.094</td>
<td>.374</td>
<td>-.072</td>
</tr>
<tr>
<td>Exposed to risk of injury</td>
<td>-.810 (4.0)</td>
<td>.474</td>
<td>-.165</td>
<td>.090</td>
<td>-.138</td>
</tr>
<tr>
<td>Cognitive Demand</td>
<td>-.848 (4.2)</td>
<td>.544</td>
<td>-.149</td>
<td>.122</td>
<td>-.126</td>
</tr>
<tr>
<td>Demand Care and Vigilance</td>
<td>-1.51 (7.5)</td>
<td>.722</td>
<td>-.190</td>
<td>.038</td>
<td>-.169</td>
</tr>
<tr>
<td>Emotional Demands</td>
<td>1.53 (7.6)</td>
<td>.624</td>
<td>.255</td>
<td>.016</td>
<td>.198</td>
</tr>
<tr>
<td>Errors have important consequences</td>
<td>.886 (4.4)</td>
<td>.469</td>
<td>.183</td>
<td>.062</td>
<td>.152</td>
</tr>
<tr>
<td>Conflict</td>
<td>1.08 (5.4)</td>
<td>.632</td>
<td>.164</td>
<td>.089</td>
<td>.138</td>
</tr>
<tr>
<td>Job Control Score</td>
<td>-.324 (1.6)</td>
<td>-.496</td>
<td>.063</td>
<td>.515</td>
<td>-.053</td>
</tr>
<tr>
<td>Support Score</td>
<td>-.067 (0.3)</td>
<td>-.450</td>
<td>.014</td>
<td>.881</td>
<td>-.012</td>
</tr>
<tr>
<td>SPPCA</td>
<td>-1.51 (7.5)</td>
<td>-.524</td>
<td>.309</td>
<td>.005</td>
<td>-.232</td>
</tr>
</tbody>
</table>

$F_{[20, 98]}=2.703, p < .01$  
Intercept = 9.741 (48.7 [SE 2.24])

Unique variability = .182  
Shared variability = .183

** p <.01; * p <.05

$R = .604$  
$R^2 = .365$  
Adjusted $R^2 = .235$
Linear mixed model (LMM) analyses (two and three repetitions)

LMM analysis was used to extend the investigation to encompass results from second and third rounds of data collections, to take account of repetitions within subjects as described in chapter 7. UBPD scores were higher (% per unit change in UBPD score) when:

- there were *awkward body or arm positions* (by approximately 7.1%);
- *emotional demands* were higher (by 6% and 8.8%);
- when subjects’ *general health* was poorer (by 3.6%);
- *workplace conflict* was higher (by 4.6%); and
- *errors have important consequences* were higher (by 3.6%).

UBPD scores were lower (per unit change in UBPD score) when:

- *SPPCA* was higher (by 5.3% and 8.7%);
- *total working hours* were longer (by 3.6% and 5.2%); and
- subject’s *age* was higher (by less that 1%
### Table 9.3. Estimates of Fixed Effects of significant IVs on UBPD using LMM (Site One)

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>Two Repetitions (n = 103)</th>
<th>Three Repetitions (n = 71)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>Estimated Effects (%)</td>
<td>Std. Error</td>
</tr>
<tr>
<td>9.74 (48.7)</td>
<td>1.63</td>
<td>184.951</td>
</tr>
<tr>
<td>Age</td>
<td>-.128 (0.6)</td>
<td>.03</td>
</tr>
<tr>
<td>Poor General Health</td>
<td>.531 (2.6)</td>
<td>.25</td>
</tr>
<tr>
<td>Total Hours Worked</td>
<td>-.720 (3.6)</td>
<td>.35</td>
</tr>
<tr>
<td>General Temporal Demands Score</td>
<td>.394 (1.9)</td>
<td>.49</td>
</tr>
<tr>
<td>Work Hard</td>
<td>.389 (1.9)</td>
<td>.49</td>
</tr>
<tr>
<td>Precise Accurate Movements</td>
<td>-.117 (0.5)</td>
<td>.35</td>
</tr>
<tr>
<td>Long Periods of Sitting And Standing</td>
<td>.154 (0.7)</td>
<td>.38</td>
</tr>
<tr>
<td>Repetitive Work</td>
<td>-.592 (2.9)</td>
<td>.36</td>
</tr>
<tr>
<td>Awkward Body Positions</td>
<td>1.43 (7.1)</td>
<td>.39</td>
</tr>
<tr>
<td>Forceful Movements</td>
<td>-.497 (2.4)</td>
<td>.35</td>
</tr>
<tr>
<td>Walk Fast Pace</td>
<td>-.016 (0.08)</td>
<td>.35</td>
</tr>
<tr>
<td>Exposed To Risk Of Injury</td>
<td>-.261 (1.3)</td>
<td>.34</td>
</tr>
<tr>
<td>Cognitive Demand Score</td>
<td>-.360 (1.8)</td>
<td>.40</td>
</tr>
<tr>
<td>Demand Care And Vigilance Score</td>
<td>-.718 (3.5)</td>
<td>.56</td>
</tr>
<tr>
<td>Emotional Demands Score</td>
<td>1.21 (6.0)</td>
<td>.48</td>
</tr>
<tr>
<td>Errors Have Important Consequences</td>
<td>.592 (2.9)</td>
<td>.33</td>
</tr>
<tr>
<td>Conflict</td>
<td>.870 (4.3)</td>
<td>.48</td>
</tr>
<tr>
<td>Job Control &amp; Variety</td>
<td>.038 (0.1)</td>
<td>.34</td>
</tr>
<tr>
<td>Support Score</td>
<td>-.155 (0.7)</td>
<td>.35</td>
</tr>
<tr>
<td>SPPCA</td>
<td>-1.07 (5.3)</td>
<td>.40</td>
</tr>
</tbody>
</table>

DV UBP
UBPD RESULTS: SITE TWO

Figure 9.3 shows mean ratings for the eyes’ (µ=2.4, SD=1.3), head’ (µ=1.6, SD=1.5), ‘neck/shoulders’ (µ=2.3, SD=1.6), ‘arms’ (µ=1.7, SD=1.6), and ‘mid back’ (µ=1.4, SD=1.5). It can be seen that typically the region of greatest discomfort were the eyes and neck/shoulder region.

UBPD scores were then created by averaging the discomfort ratings for the body parts ‘head’, ‘neck/shoulders’, ‘arms’ and ‘mid back’. The overall mean (using the 0-5 point scale) was µ=1.9, SD 1.1, similar to site one µ= 1.5 SD 1.1.
The Distribution of the scores in both rounds were slightly positively skewed as subjects tended to report low levels of UBPD (see Figure 9.4). A one-way ANOVA showed no statistical difference between UBPD scores over the two rounds.

**IDENTIFICATION OF FACTORS INFLUENCING UBPD**

**Preliminary analyses**

Bivariate correlations between UBPD and other measured constructs, grouped into the major domains identified by the JLM, are shown in Table 9.1 of Appendix 9. The results of the preliminary multivariate analyses using MR and LMM as previously described are reported in Appendix 9.

Variables where the bivariate correlations were 0.3 or higher (for at least one survey round), or that were statistically significant for at least two of the rounds, or which were found to be significant in the multivariate analyses were:

- five of the six General and Temporal Work Demands: time pressure and deadlines, too much to do, unpleasant working hours, increasing workload pressure and responsibility cf. two at site two: time pressure and deadlines, and unpleasant working hours
two of one of the eight Physical Work Demands: work very hard, awkward positions cf. one at site one: awkward arm and body positions

none of the Non-physical Demands cf. three at site one: demand for care and vigilance, emotional demands and errors important consequences

one of the seven Contextual Demands and Impediments: environmental and informational impediments cf. at site one: conflict

one of the four Job Control and Variety factors: decision latitude cf. two at site one: decision latitude, influence

none of the five Support factors cf. one at site one: supervisor support

SPPCA same at site one

one of the Personal and Non-work variables: general health cf. two at site two: age and general health.

MULTIVARIATE ANALYSES

Stepwise Sequential Multiple Regression (round one data)

Results of the sequential multiple regression (MR), are summarised below and in Tables 9.4 and 9.5 all IVs are in z scores:

• Block one - Personal & Non-Work Factors: \( R^2 = .191 \), \( F [1, 46] = 10.837, p < .01 \). One factor was entered, poor general health, this explained 19.1% of the variance per unit change in UBPD scores.

• Block two - General and Temporal Work Demands: \( R^2 = .199 \), \( F [2, 45] = 5.583, p < .01 \). In the preliminary analysis no individual factor explained a substantial amount of variance, so an average of all factors within this domain was used; general and temporal demands score (responsibility was omitted since, unlike the other factors, there was no clear hypothesis concerning the direction of any effect that it might have on discomfort.). However, this explained little of the variance in scores.

• Block three - Physical Work Demands: \( R^2 = .318 \), \( F [5, 43] = 4.016, p < .01 \). Three factors were entered awkward body or arm positions (Z score), precise accurate movements (Z score), periods of sitting and standing in same position (Z score), these explained 12% of the variance per unit change in UBPD score.

• Block four - Non-physical Work Demands: \( R^2 = .329 \), \( F [6, 42] = 3.436, p < .01 \). In the preliminary analysis, no individual factor explained a substantial amount of variance, so an average of the factors (cognitive demands, demand for care and vigilance, emotional demands,
and *errors have important consequences*) was entered, and this explained 1.1% of the variance pro rata.

- **Block five - Contextual Demands & Impediments:** $R^2 = .330$, $(F[7, 41] = 2.883, p < .01)$. In the preliminary analysis, no individual factor in this domain explained a substantial amount of variance, so an average score was entered, *impediments (Z score)*, but this explained little variance.

- **Block six - Job Control and Variety:** $R^2 = .351$, $(F[8, 40] = 2.699, p < .01)$. In the preliminary analysis, no individual factor explained a substantial amount of variance, so one factor representing all items in this domain was entered *job control and variety (Z score)*, but this explained little variance.

- **Block seven - Support:** $R^2 = .352$, $(F[9, 39] = 2.350, p < .05)$. In the preliminary analysis no individual factor explained a substantial amount of variance, so one factor was entered representing all items within this domain *support score (Z score)* but this explained very little variance.

- **Block eight - SPPCA:** $R^2 = .372$, $(F[10, 38] = 2.25, p < .05)$. Poor *self-perceived performance* was a single factor in this block, and it accounted for 2% ‘pro rata’ of variance in scores.

Table 9.4 shows that the F-changes between blocks in the above sequence were significant (in red) at the first and approached significance at the third block.

**Table 9.4. Models of IVs and UBPD (site two, round one)**

<table>
<thead>
<tr>
<th>Block One- personal &amp; non-work factors</th>
<th>R Square</th>
<th>R Square Change</th>
<th>F-change</th>
<th>Sig. F-change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block One- personal &amp; non-work factors</td>
<td>.191</td>
<td>.191</td>
<td>11.108</td>
<td>.002</td>
</tr>
<tr>
<td>Block Two- general job demands</td>
<td>.199</td>
<td>.008</td>
<td>0.439</td>
<td>.511</td>
</tr>
<tr>
<td>Block Three- physical task demands</td>
<td>.318</td>
<td>.120</td>
<td>2.514</td>
<td>.071</td>
</tr>
<tr>
<td>Block Four – non-physical task demands</td>
<td>.329</td>
<td>.011</td>
<td>0.682</td>
<td>.414</td>
</tr>
<tr>
<td>Block Five contextual demands &amp; impediments</td>
<td>.330</td>
<td>.001</td>
<td>0.040</td>
<td>.843</td>
</tr>
<tr>
<td>Block Six- job factors</td>
<td>.351</td>
<td>.021</td>
<td>1.272</td>
<td>.266</td>
</tr>
<tr>
<td>Block Seven – support factors</td>
<td>.352</td>
<td>.001</td>
<td>0.067</td>
<td>.798</td>
</tr>
<tr>
<td>Block Eight- SPPCA</td>
<td>.372</td>
<td>.020</td>
<td>1.233</td>
<td>.274</td>
</tr>
</tbody>
</table>

Table 9.5 below, shows the unstandardized regression coefficients (B), and intercept, the standardized regression coefficient ($\beta$), the semipartial correlation coefficients ($sr^2$) and $R^2$, and adjusted $R^2$ values for the final model.
With this combination of variables only awkward body or arm positions (in red) was significant. The IVs in total explained 37.2% (20.7% adjusted) of the variance per unit change in UBPD score.

Table 9.5. Sequential Multiple Regression of UBPD with Significant IVs (site two, round one)

<table>
<thead>
<tr>
<th>Variables</th>
<th>B (%)</th>
<th>SE</th>
<th>β</th>
<th>Sig.</th>
<th>sr²i</th>
<th>sr²</th>
<th>F (10, 38) =2.25, p &lt; .05</th>
<th>Intercept = 5.821 (23.3 [SE 2.68])</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor General Health</td>
<td>1.03 (4.1)</td>
<td>.768</td>
<td>.290</td>
<td>.187</td>
<td>.173</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Temporal Demands Score</td>
<td>-.498 (1.9)</td>
<td>.819</td>
<td>-.101</td>
<td>.547</td>
<td>.078</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Precise Accurate Movements</td>
<td>-1.27 (5.1)</td>
<td>.769</td>
<td>-.236</td>
<td>.106</td>
<td>.213</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Awkward Body or Arm Positions</strong></td>
<td>1.92 (7.6)</td>
<td>.794</td>
<td>.362</td>
<td>.021</td>
<td>.311</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long Periods of Sitting and Standing</td>
<td>.493 (1.9)</td>
<td>.749</td>
<td>.104</td>
<td>.514</td>
<td>.085</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-physical Task Demands Score</td>
<td>-.493 (1.9)</td>
<td>.892</td>
<td>-.093</td>
<td>.584</td>
<td>.071</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impediments Score</td>
<td>.591 (2.3)</td>
<td>.920</td>
<td>.127</td>
<td>.524</td>
<td>.083</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Job Control and Variety Score</td>
<td>-.738 (2.9)</td>
<td>.808</td>
<td>-.166</td>
<td>.367</td>
<td>-.117</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supports Score</td>
<td>-.346 (1.3)</td>
<td>1.027</td>
<td>-.070</td>
<td>.738</td>
<td>-.043</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPPCA</td>
<td>-1.02 (4.1)</td>
<td>.926</td>
<td>-.190</td>
<td>.274</td>
<td>.143</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** p < .01; * p < .05

Unique variability = .152
Shared variability = .197

R = .610
R² = .372
Adjusted R² =

DV: UBPD

Linear Mixed Model Analyses (two and three repetitions)

LMM analysis was used to extend the investigation to encompass results from the second repetition of data within some subjects. To facilitate interpretation of the results (given that factors are entered in one block using this method), only the main variables (as identified above) from the most centrally important domains were included, results are shown in Table 9.6.

The following variables had the greatest effect on the UBPD scores:

UBPD scores were higher (per unit change in UBPD score) when:

- **SPPCA** was poorer (by 7.5%)
- **Support** was poorer (by 7.3%)
- **General health** was poorer (by 6.5%) and
- **Awkward arm and body positions** were more frequent (by 5.4%).

UBPD scores were lower (per unit change in UBPD score) when:

- **support** was higher (by 7.3%).
Table 9.6. Estimates of Fixed Effects UBPD and significant IVs (site two)

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>Estimated Effects (%)</th>
<th>Std. Error</th>
<th>df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>9.39 (37.5)</td>
<td>.64</td>
<td>50.961</td>
<td>.000</td>
</tr>
<tr>
<td>Poor General Health</td>
<td>1.64 (6.5)</td>
<td>.72</td>
<td>48.927</td>
<td>.028</td>
</tr>
<tr>
<td>General Temporal Demands Score</td>
<td>1.09 (4.3)</td>
<td>.69</td>
<td>44.044</td>
<td>.120</td>
</tr>
<tr>
<td>Awkward Body or Arm Positions</td>
<td>1.35 (5.4)</td>
<td>.67</td>
<td>49.883</td>
<td>.051</td>
</tr>
<tr>
<td>Long Periods of Sitting and Standing</td>
<td>-0.22 (0.9)</td>
<td>.76</td>
<td>50.675</td>
<td>.769</td>
</tr>
<tr>
<td>Non-physical Task Demands</td>
<td>0.66 (2.6)</td>
<td>.79</td>
<td>51.975</td>
<td>.401</td>
</tr>
<tr>
<td>Impediments Score</td>
<td>-0.46 (1.8)</td>
<td>.67</td>
<td>51.975</td>
<td>.496</td>
</tr>
<tr>
<td>Job Control and Variety Score</td>
<td>-0.83 (3.3)</td>
<td>.86</td>
<td>49.735</td>
<td>.340</td>
</tr>
<tr>
<td>Supports Score</td>
<td>-1.83 (7.3)</td>
<td>.75</td>
<td>51.959</td>
<td>.019</td>
</tr>
<tr>
<td>SPPCA</td>
<td>-9.39 (7.5)</td>
<td>.64</td>
<td>50.961</td>
<td>.000</td>
</tr>
</tbody>
</table>

OVERVIEW OF RESULTS: BOTH SITES

Table 9.7 shows the harmonised UBPD scores (means, SDs) for each of the sites. Virtually the same means were reported in both sites, and a one-way ANOVA confirmed that scores did not differ significantly between the sites.

Table 9.7. Comparisons of UBPD Scores for both sites all rounds

<table>
<thead>
<tr>
<th>Round</th>
<th>Site One</th>
<th>Site Two</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Whole sample mean (SD)</td>
<td>n</td>
</tr>
<tr>
<td>Round 1</td>
<td>1.4 (1.1)</td>
<td>120</td>
</tr>
<tr>
<td>Round 2</td>
<td>1.6 (1.2)</td>
<td>103</td>
</tr>
<tr>
<td>Round 3</td>
<td>1.6 (1.2)</td>
<td>71</td>
</tr>
<tr>
<td>Grand Mean</td>
<td>1.5 (1.2)</td>
<td>294</td>
</tr>
</tbody>
</table>

For ease of comparison, the results of the multivariate analyses for both sites are combined and presented in Table 9.8. This shows all the work characteristics and personal and non-work factors that were included in the final multivariate analyses, with those that were statistically significant at p<.05 level in red, and those with significance between .05 and 1 indicated in blue.

At site one, approximately 34.9% (using the $R^2$) or 21.7% (using the adjusted $R^2$) and, at site two, approximately 37.2% (using the $R^2$) or 20.7% (using the adjusted $R^2$) of the variance in UBPD scores was predicted. The probable reasons for the small variance explained by these factors, and what else might have been needed to be measured is discussed in the following sections.
### Table 9.8. Significant IVs predicting Upper Body Part Discomfort (both sites all multivariate analysis methods)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Site One</th>
<th>Site Two</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR (n = 120)</td>
<td>LMM (2 repetitions n = 103)</td>
<td>LMM (3 repetitions n = 71)</td>
</tr>
<tr>
<td><strong>Intercept</strong></td>
<td>9.59 (47.9)</td>
<td>9.74 (48.7)</td>
</tr>
</tbody>
</table>

**Personal & Non-work variables**

| Poor General Health | 0.17 (0.8) | 0.052 | 0.531 (2.6)** | -0.006 (0.03) | 1.03 (4.1) | 0.290 | 1.64 (6.5)* |
| Age | -0.10 (0.5)* | -1.197 | -0.128 (0.6)* | 1.03 (4.1) | 0.290 | 1.64 (6.5)* |

**General Job Demands**

| Total Hours Worked | -0.53 (2.6) | -0.123 | -0.720 (3.6)* | -1.05 (5.2)** |
| General Temporal Demands Score | 1.45 (7.2)* | 0.284 | 0.394 (1.9) | 0.519 (2.5) | -0.49 (1.9) | -0.101 | 1.09 (4.3) |

**Task Level Demands**

| Work Hard | 1.13 (5.6) | 0.227 | 0.389 (1.9) | 0.279 (1.3) |
| Precise Accurate Movements | -0.16 (0.8) | -0.036 | -0.117 (0.5) | -1.27 (5.1) | -0.236 |
| Long Periods of Sitting and Standing | -0.24 (1.2) | -0.056 | 0.154 (0.7) | 0.49 (1.9) | 0.104 | -0.22 (0.9) |
| Repetitive Work | -0.23 (1.1) | -0.051 | -0.592 (2.9) | -0.364 (1.8) |
| Awkward Arm and Body Postures | 0.78 (3.9) | 0.168 | 1.43 (7.1)** | 1.424 (7.1)** | 1.92 (7.6)* | 0.362 | 1.35 (5.4)* |
| Forceful Movements | -0.55 (2.7) | -0.120 | -0.497 (2.4) | -0.139 (0.7) |
| Walk Fast Pace | -0.42 (2.1) | -0.092 | -0.016 (0.08) |
| Exposed to Risk of Injury | -0.70 (3.5) | -0.144 | -0.261 (1.3) | -0.393 (1.9) |
| Specific Task Demands Score | -0.49 (1.9) | -0.093 | 0.66 (2.6) |
| Cognitive Demand Score | -0.75 (3.7) | -0.133 | -0.360 (1.8) | -0.490 (2.4) |
| Demand Care and Vigilance Score | 1.64 (8.2)* | 0.207 | 0.718 (3.5) | 0.492 (2.4) |
| Emotional Demands Score | 1.05 (5.2) | 0.175 | 1.21 (6.0)** | 1.76 (8.8)** |
| Errors Important Consequences | 0.93 (4.6) | 0.193 | 0.592 (2.9) | 0.737 (3.6)* |

DV: UBPD* p<.05, ** p<.01  Blue approached significance between .05-1

Table 9.8 continued on next page
Table 9.8. Significant IVs predicting Upper Body Part Discomfort (both sites all multivariate analysis methods)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Site One</th>
<th>Site Two</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MR (n = 120)</td>
<td>LMM (2 repetitions n = 103)</td>
</tr>
<tr>
<td>Intercept</td>
<td>9.59 (47.9)</td>
<td>9.74 (48.7)</td>
</tr>
<tr>
<td>Conflict</td>
<td>.370 (1.8)</td>
<td>-.078</td>
</tr>
<tr>
<td>Impediments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Job Control &amp; Variety Score</td>
<td>- .307 (1.5)</td>
<td>-.065</td>
</tr>
<tr>
<td>Support Score</td>
<td>-.009 (0.4)</td>
<td>-.002</td>
</tr>
<tr>
<td>SPPCA</td>
<td>-1.74 (8.7)**</td>
<td>-.356</td>
</tr>
</tbody>
</table>

| $R^2$               | .365                       |                            |                            | .372        |                            |
| Adjusted $R^2$      | .235                       |                            |                            | .207        |                            |

DV: UBPD * p<.05, ** p<.01 Blue approached significance between .05-1
Additional Data from Job Description

Job Type and Level

Job type and level data were analysed separately because of the expected high interactions with JLI variables (see Appendix 8, Tables 7.103-105.). No significant differences were detected between the UBPD scores between the job types (both sites combined), but differences between the job levels for site one were detected.

Overall, the Job Description had revealed that the more junior offices were typically required to undertake more intense computer-based activity with relatively fewer opportunities for breaks. It was therefore not surprising that they reported the highest levels of UBPD.

Following is a discussion of conditions that were identified as significant predictors of UBPD and related to significant differences in work demands or factors between the jobs types or levels.

REVIEW AND DISCUSSION OF RESULTS

In the JLM, UBPD was seen as a ‘wellbeing cost’, which reflected a poor ‘job-person’ fit. It was expected that discomfort would occur as a result of the direct effects of physical work demands and also, albeit less directly, from the physical and psychological effects of Stress. Low levels of discomfort were thought to probably reflect some degree of physical fatigue, whereas extreme physical discomfort was thought more likely to reflect underlying tissue pathology and early signs of musculoskeletal injury (Kumar, 2001). Bodily discomfort is important not only because it impairs wellbeing, but because it limits the physical capacities of the person to meet the job requirements.

There is a commonly held assumption that physical discomfort will lead to increased rates of strains and sprains, and if these become chronic, this will in turn be reflected by higher rates of musculoskeletal disease (MSD) (NIOSH, 1997). The Australian Institute of Health and Welfare (1994) reported that within the general working population musculoskeletal disorders which were severe enough to require some form of medical assistance were reported by 29% of Australians within a working age.

While at both sites the severity of UBPD was low, the prevalence was high. In this study, 55% at site one and 27% of people at site two reported they had no or extremely low levels of discomfort over the last week. At site one, severe and extreme discomfort was reported by only 13% of
people and at site two by 21.8%. Clearly, some background level musculoskeletal discomfort was actually very common at both sites.

While it might be argued that this rate of reporting is an artefact of the measuring instrument, the Job description (see Chapter 8) had objectively confirmed that most subjects had relatively high static physical demands which have been empirically demonstrated to be associated with MSDs (e.g. Hagberg, Silverstein et al., 1995; NIOSH, 1997). Further, the Job Description had revealed both sites were experiencing work intensification associated with downsizing and hence it was assumed that these levels could reflect a real pattern. Alternatively, if a healthy worker effect was present it may also be an underestimation. It was concluded that it was likely that these levels reflected the presence of both some physical fatigue and, for a small number of people with severe pain, possible underlying pathology.

Comparison with other workplace studies is difficult as epidemiological research often uses prevalence over different time scales, as well as severity measures. However, as an indication of UBPD prevalence over a 12-month period in a study of office workers, Sillanpaa et al. (2003) found 63% of symptoms to the neck, 24% shoulders, 35% elbows, 18% lower arms and wrists, and 16% fingers. Tornqvist et al. (2000) in a study of body discomfort amongst 1,555 Swedish computer users, found 51% of the men, and 72% of the women reported some symptoms for at least three days over the last month. Marcus and Gerr (1996), when examining UBPD amongst female office workers (n=416), found 63% reported some degree of neck or shoulder and 34% arm or hand symptoms in the past two weeks.

There are surprisingly few recent studies of Australian office environments, which report the prevalence of work-related UBPD symptoms within a normal working population (compared to those generated from samples of workers’ compensation claims). However, a study of clerical officers within the Australian Taxation Office (using a measure similar to that used in this study) showed a prevalence rate of upper body discomfort of 6% over the previous two days which was rated as ‘severe’ by 16% and ‘extreme’ by 3% of subjects (Comcare, 1997). Again, using a rating scale similar to that of the present study, Martin (2004) reported that from 558 Australian Occupational Therapists 62.2% had no discomfort, with 32.1% reporting some discomfort over the last week. Of those that did report discomfort, it was most commonly experienced in the neck, upper back, and arms.

Clearly, the UBPD levels at both the present white-collar work-sites were not dissimilar to those reported by others.
Effects of Personal & Non Work Variables

The impact of workplace factors on wellbeing states was the prime focus of this study, nevertheless the profound influence of the persons’ premorbid physical state and non-work-related factors on UBPD was acknowledged. Accordingly, factors of this type which were identified by the preliminary analyses as having a significant effect on UBPD (see Appendix 9) were entered into the first block of the sequential regressions and included in LMM analyses. Only the factors age and health met the inclusion criteria and were included in this first MR block, the F-change was large and significant (7.1% at site one and 19.1% at site two).

At site one, UBPD was lower when subjects were older (this information was not collected at site two). While it might be argued that this was because older staff tended to be more senior and so have greater job control, this was not confirmed by examination of the bivariate correlations with age and control. But older people did have significantly less stress at home and less conflict between home and work demands suggesting, it may be these factors, which were influencing the relationship between UBPD and age.

As expected, at both sites UBPD scores were higher when people rated their general health as poorer, reaching significance at site one.

Effects of the Work Demands

General and Temporal Job Demands

Of the six factors in the general and temporal job demands domain, an average score of all the items general and temporal demand score was used and as total hours worked. However, based on the F-change, these factors had negligible impact on UBPD.

For the purposes of this analysis even though total hours worked had not been identified in the preliminary investigations, given its theoretical relevance as a significant predictor of UBPD, it was included in the final model. It had been hypothesised that UBPD would be higher when there was longer working hours, as the duration of exposure to physical hazards was greater, and there was an increasing likelihood of physical and mental fatigue. Nonetheless, at site one when total hours worked were longer, UBPD scores were marginally lower but as the relationship was not significant this result was not considered reliable. In case this was due to a curvilinear

---

22 site one -.793, p<.01 cf site two -.724, 
23 site one -.795, p<.01 cf site two -.805, p<.01 
24 responsibility omitted since unlike the other factors, there was no clear hypothesis concerning the direction of any effect that it might have on discomfort

25 site one µ=43.8 hours pw SD=11.7; and site two µ=39.7 hours pw SD=7.8
relationship, UBPD at five groups of working hours were compared\textsuperscript{26} (shown in Figure 9.5), where it can be seen that no particular relationship is observable. A one way ANOVA confirmed the differences between these groups and UBPD scores were non-significant.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure9.5.png}
\caption{Box Plot of Total Hours Worked & UBPD Scores}
\end{figure}

Others have demonstrated a significant relationship between long working hours and UBPD. IJzelenberg, Molenaar, & Burdorf (2004), in their study of bodily discomfort amongst dry cleaning workers (n= 431), reported that discomfort levels were higher amongst people who worked more than 36 hours per week\textsuperscript{27}. Lipscomb et al. (2002), when exploring musculoskeletal disorders in a sample of 1,163 nurses, reported that working demanding schedules (which included working more than 8 hours per day) was significantly associated with increased musculoskeletal disorders\textsuperscript{28}. They reported that working "long hours" (>12 hours/day, >40 hours/week) and "off hours" (weekends and "other than day shifts") were associated with a 50-170% increase in the age-adjusted odds ratio for musculoskeletal disorders in the three body sites. Interestingly, they noted that when an adjustment for ‘psychological’ and ‘physical job demands’ occurred, this reduced the odds ratios slightly, and suggested some association between musculoskeletal disorders and the work schedules were due to increased exposure to job demands. Sparks et al. (1997), in a meta-analysis of working hours and health, showed a small

\textsuperscript{26} 35 hrs pw; 36-45 hrs pw; 46 -55 hrs pw, 56-65 hrs pw and >66 hrs pw
\textsuperscript{27} OR 0.7 [CI 0.4–1.1]
\textsuperscript{28} neck OR 1.10, [95% CI 1.00-1.21], shoulder OR 1.12, [95% CI 1.01-1.23]), back OR 1.16, [95% CI 1.06-1.27]
but significant positive trend of increasing hours with health symptoms. Williams and Cooper (1998) also found moderate relationships between higher ‘workloads’\(^{29}\) and physical health symptoms\(^{30}\).

In contrast, to the unconvincing associations between lower UBPD and long working hours in this study, an increase in UBPD (reaching significance at site one) was observed when *general and temporal demands scores* were higher. The review of the literature suggested that temporal pressure not only increases the rate of work, but also generates higher emotional tension, both of which are reported to lead to higher levels of background muscle tone and an increased propensity for injury (for example Aarås 1987; Armstrong *et al.*, 1988; Kumar, 2001 etc).

IJzelenberg *et al.* (2004) also found associations between the occurrences of upper extremity pain with high ‘job demands’, and with ‘job strain’. Bellman *et al.* (2003) in a study of occupational stress (n=204) from a range of Australian organisations reported moderate positive relationships between high ‘workload’ (measuring work difficulty) and symptoms of physical tension and discomfort\(^ {31}\). Finally Bongers *et al.* (1993) in an extensive review of 30 epidemiological studies, concluded that there was evidence that high ‘perceived workload’, ‘time pressure’ and ‘monotonous work’ were all related to increased rates of MSDs.

However, as will be also found with other wellbeing outcomes, the relationships with these kinds of demands vary, moderated by a range of factors, including the level of demands, health status, home support, choice about work patterns and rewards for effort. Therefore, it may be that for these two samples, because most had good levels of control and support, physical discomfort was moderated even though some people worked long hours.

**Physical and Non-physical Work Demands**

For this aspect of wellbeing, it was considered advisable to consider physical factors which were conceptually strongly related to UBPD as individual items rather than as a single construct score. Included in the final analysis were the items: *required to work very hard, precise accurate movements, long periods of sitting and standing in same position, repetitive work, maintain awkward body or arm positions, forceful movements and actions, walk fast pace* and *exposed to risk of injury or illness*. Overall, the relative impact of these factors, based on the F-change in the MR was significant (13.2% at site one and 12% at site two) contributing more to the variance explained than any other domain.

---

\(^{29}\) quantitative load as well as hours of work

\(^{30}\) *r*=-.21, *p*<.05

\(^{31}\) *r*=.38, *p*<.05
It was noted that, consistent with the ergonomic literature and with the results of the Job Description\textsuperscript{32}, maintaining awkward arm and body positions was one of most significant predictor of UBPD (e.g. Buckle & Devereux, 2002; Keyserling, 2000,b).

Korhonen et al. (2003) states that musculoskeletal discomfort in the neck–shoulder and upper extremities associated with computer-based work is caused by, amongst other things, increasing hours of use with “incomplete work–rest cycle control, especially when using input devices, such as a keyboard or a mouse”, and that typically the use of computers involves sustained awkward “non-neutral postures, such as neck rotation and shoulder abduction.”

Multiple authors have demonstrated associations between these kinds of physical demands and work-related upper body muscle pain. Miranda et al. (2002) in a longitudinal study reported increased rates of shoulder pain in the presence of factors such as heavy loads, awkward work postures, and ‘mental stress’. Cassou et al. (2002) found a relationship between the duration of awkward work postures and the incidence of chronic neck and shoulder pain. IJzelenberg, Molenaar and Burdorf (2004) reported amongst dry cleaning workers significant relationships between the occurrence of pain in the upper extremities and awkward back posture, manual materials handling, static back posture; strenuous arm movements and a perceived physical load.\textsuperscript{33}

Three non-physical demands were also considered\textsuperscript{34}; these explained approximately 8% at site one, but only 1% at site two of the variance in UBPD scores. Demand for care and vigilance, which is associated with visually demanding work and static postures, was a significant predictor of UBPD at site one. It had also been expected that emotional demands would have an indirect effect on were site Figure discomfort by increasing background muscle tension. At one when the work was emotionally demanding UBPD scores higher, this relationship is show in Figure 9.6.

\textsuperscript{32} work tasks were primarily computer-based which especially during computer mouse use was associated with the requirement to sustain awkward arm and hand positions for prolonged periods.

\textsuperscript{33} upper extremity pain and ‘awkward back posture (OR=1.6 [1.0–2.4]’, ‘manual materials handling’ (OR=1 [0.6–1.6]’, ‘static back posture; (OR=1.0 [0.5–2.2] ‘strenuous arm movements’ (OR=1.9 [1.1.3.1], a ‘perceived physical load’ (OR=1.5 [0.9–2.2]

\textsuperscript{34} demand for care and vigilance, emotionally demands and important consequences of errors
At site one, important consequences of errors were also found to be a significant predictor of UBPD, perhaps reflecting its role as a psychological stressor.

**Work-related Contextual Demands and Impediments**

Of the seven factors in this domain, only one factor (conflict) was included in the final model at site one. It had been expected that there would be an association between UBPD and these demands. At site two, preliminary analyses revealed no significant relationships between any of these factors and UBPD, so a composite ‘impediments score’ was created and used instead. However, based on the F-change in the MR these factors only made a small contribution to variance explained, at site one 2.2% and nothing at site two.

The multiple regressions showed significant relationships between workplace conflict and UBPD scores. Because impediments were likely to increase the effort required to maintain performance, it was thought that they would indirectly increase the likelihood of UBPD. To ensure these factors were represented in the model, an impediments score (as previously described) was also entered at site two. This added little to the variance explained. So despite the conceptual appeal, most factors in this domain (except conflict) had virtually no effect on UBPD scores at these sites.
Job Control and Variety

Because low levels of control might increase the difficulty of the job, alter motivation to spend effort, or change the way the discomfort was perceived, it had been expected that this might be associated with higher UBPD scores. However, of the four factors in this domain, the preliminary analysis had revealed no significant relationships between UBPD and any of these factors.

To confirm that this was the case when included in a multivariate model analyses, a single ‘control score’ was created from the four factors in that domain, and this used in the final model. Nevertheless, at both sites control appeared to have little impact on physical discomfort levels using any of the regression methods at these sites; this contrasts to results reported by others.

MacDonald, Karasek, Punnett and Scarf (2001) looked at the differences between white (n=190) and blue-collar workers (n=220). They found modest significant associations for upper extremity symptoms in blue-collar workers for ‘job strain’ (.58), ‘psychological demands’ (.24), ‘decision latitude’ (-.61), ‘supervisor support’ (-.25) and weaker correlations for white-collar workers for ‘job strain’ (.34), ‘psychological demands’ (.26), ‘decision latitude’ (-.24), and ‘supervisor support’ (-.19). Hagen et al. (1998) in a study of the relationship between work tasks, perceived psychosocial job stress and MSDs with over 800 manual, machine and clerical workers showed that the prevalence of neck/shoulder disorders were more common when there were increasing ‘psychosocial demands’ and when there was low ‘intellectual discretion’. IJzelenberg et al. (2004) also found an association between the occurrence of pain in the upper extremities and low job control, poor co-worker and supervisor support and with low Job Satisfaction. Possible explanations for a lack of significant findings in this study are discussed in the next section.

Support

It was also expected that support would indirectly influence UBPD because of its role as a moderator of demand. Of the five factors grouped in this domain, preliminary analysis revealed few significant relationships. Like control, in order to preserve representative factors from this domain in the final model, a single ‘support score’ was created. In site two, this reached significance using LMM, and UBPD scores were higher when support was poor, but the relative impact of these factors on the F-change was negligible.

This result contrasts with the role of support as a predictor of bodily discomfort, cited by others. Toomingas et al. (1997) study of psychosocial work conditions and musculoskeletal symptoms
(from a range of occupations) reported association between high mental demands and low social support and coexisting symptoms in the neck and low back (but contradictory associations for shoulder discomfort). Theorell et al. (1991) reported association between demands-control-support variables and symptoms of the back, neck and shoulders. De Jonge, Bosma, Peter and Siegrist (2000) found that those who had low demands/high control, had fewer physical symptoms that those who were experiencing high demands/low control.

One explanation for the lack of significant findings in this study for both control and support, might be that the research design intentionally included physical work demands early in the regression sequences before either were entered, so borrowing some variance. To test this idea the control and support factors were entered into an exploratory regression before the task factors. Even with this strategy their F-change was still extremely small and non-significant. In addition, no significant relationships were identified using LMM analysis, a technique when all factors are considered concurrently.

The Job Description had revealed significant differences in both job control and support between the job types and levels but that, overall, most people had quite good support and moderate levels of control. Of note was that examination of those people with the worst support and lowest control (the Communications and Help Desk Officers) did show relationships with UBPD in the direction reported by others. This result might suggest that where control and support are relatively high their impact, while important, is less obvious compared to the physical demands.

**Effects of SPPCA**

It was assumed that SPPCA would not only reflect people’s assessment of their performance, but also capture some of the variance from variables which while not measured, might impede or enhance coping capacity. While the F-change in the MR was small at both sites (5.4% and 2%), even when added last in the MR sequence, it explained substantial proportions of the UBPD variance.

It may be that when effort at work results in success, UBPD is perceived as less severe and debilitating. Although (as will be discussed in Chapter 14) when people are not experiencing high UBPD, performance capacity and adequacy is viewed as higher.

---

36 UBPD and decision latitude $r = -.426$, $p < .01$, and supervisor support $r = -.384$, $p < .05$
Measurement Issues

The UBPD scale, developed from the work of Corlett (1976) and Corlett & Bishop (1992), proved reliable with high Cronbach’s alpha at both sites\(^{37}\). While this scale asked for physical discomfort ratings over the last week, it is probably not unreasonable to assume that ratings also represent some ‘carry over’ discomfort from previous weeks. The inclusion of ratings of eye discomfort is recommended in future iterations of the scale in white-collar worksites.

CONCLUSIONS

Overall, the expected associations predicted in the JLM between UBPD and various independent variables were confirmed. While overall, the variance explained at both sites was quite low, this was only using two personal factors, selected general and specific work demands, and SPPCA. It was noteworthy that in these largely white-collar workplaces, where support and control were good, these factors did not emerge as significant predictors of UBPD.

Clearly while further research is required to identify additional predictors of UBPD, given the strong and significant correlations between UBPD and other aspects of wellbeing such as Stress, Job Satisfaction and Arousal, it might be expected that the addition of these factors would have increased the variance explained.

\(^{37}\) Reliability coefficient site one $\alpha = .815$ Guttman split-half $.811$, part 1 $\alpha = .640$, part2 $\alpha = .675$; and site two Reliability coefficient $\alpha = .789$ Guttman split-half $.770$, part 1 $\alpha = .676$, part2 $\alpha = .583$