Possible OHS impacts of Motorcycle Separate Bundle Delivery (SBD)

Report to Australia Post

October 2010

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SUMMARY REPORT

Introduction

This project evaluated whether introduction of the Separate Bundle Delivery (SBD) process is likely to affect the occupational health and safety (OHS) of Postal Delivery Officers (PDOs), focusing particularly on the possible effects on PDOs' mental workload, and on the physical demands PDOs experience during the SBD delivery process.

The SBD process reduces the required amount of manual sorting work (indoor work), but it necessarily slows down the process of mail delivery (outdoor work) because at each delivery point there is more than one source of mail,[1] whereas previously there was just one. This change raises the following questions:

- Does SBD significantly increase the mental workload of PDOs?
- If PDOs' mental workload is increased, what are the OHS implications, if any?

The initial brief for this project was to answer the above two questions, with the main focus on changes to aspects of the outdoor work. Following the main data collection phase, Australia Post requested that the brief be expanded to include:

- assessment of ALL foreseeable hazards/risks, including the physical demands
- additional information regarding whether the physical demands of SBD are acceptable, and any recommended additional controls related to such demands.

This Summary Report provides a self-contained overview of the project, its findings and recommendations. It first gives a brief account of the methods used to collect and analyse data related to potential hazards. These hazards are related to levels of mental workload (of which 'stress' is a component), fatigue, physical aches and pains, and the physical demands of the SBD process itself. This is followed by a summary of key conclusions and related recommendations for each of the two main types of OHS outcomes that are possibly affected

[1] Cognitive complexity of the task, and therefore the time required, is increased by the existence of additional sources, independently of whether or not there are articles from each source at each delivery point. The key factors are the *number of sources*, modified by the *probability* of there being something to be delivered from each source (see Hoffmann et al, 1993, for further explanation).

by implementation of SBD: (1) injuries due to motorcycle riding accidents; and (2) musculoskeletal disorders (MSDs).

A more detailed account of the evidence on which conclusions were based is provided by the following Detailed Report with its various Appendices.

What we did

Interviews with the participating PDOs were conducted on five days during late June and early July 2010, in Queensland (Heathwood), New South Wales (Lakemba, Seven Hills), and Victoria (Seaford, Mount Waverley). These interviews were supplemented by some informal observations of SBD trial participants performing their work.

During the interviews we used a validated method (the NASA Task Load Index or TLX) to obtain quantitative ratings of mental workload and some related constructs from PDOs participating in the SBD trial. Ratings were obtained for each of a set of workload dimensions, for each of the different work processes available for comparison (V-sort, Merging, SBD). Ratings of fatigue and physical aches and pains were also obtained, and participants were asked about potential differences between the work processes in road safety outcomes. Ratings data were analysed using the SPSS 17.0 Statistics software package.

Much later in the project, additional information was obtained to assess OHS risk related to physical demands of the SBD delivery process. Three different people, intended to represent PDOs of short, average and tall stature, were video-recorded when astride a fully loaded stationary motorcycle, and when delivering mail using the SBD process. Various aspects of the physical task demands associated with performing this task were directly measured, and some additional data on factors not amenable to direct observation within the project timeframe were provided by Australia Post.

These data were analysed to assess MSD risk using several different methods: the Rapid Upper Limb Assessment (RULA) method; the OCRA Checklist; the 3D Static Strength Prediction Program (3D SSPP); and some additional (bio)mechanical calculations.

Conclusions and recommendations are as follows.

Possible Effects of SBD on Road Safety

From the road safety research literature there is strong evidence that risk can be affected by mental workload, by stress, and by fatigue (e.g. see Fuller, 2005; Huey & Wickens, 1993; Macdonald 1979, 2003, 2006a, 2006b; Matthews et al, 2000; Recarte & Nunes, 2003; Rowland et al, 2007; Swaen et al, 2003).

Mental Workload and Stress

From this project there was evidence that mental workload related to SBD delivery was higher than with the current delivery process[2]. However, some of the causes for this are probably short-term ones. Specifically, trial participants had not yet had time to 'get up to speed' on the new process, and they were having to cope with what they perceived as high levels of mis-sorts (most of which were believed by the PDOs to be machine-generated).

Consequently, it is likely that PDO levels of mental workload (including stress) were higher during the trial than would be expected if mis-sort levels were much lower and their skill levels had increased to near maximum. However, the extent of expected changes in mental workload following full implementation and 'bedding down' of the SBD process and related job design changes is unclear, so the extent of any decrease in road safety due to these factors is difficult to predict. It is therefore essential that mental workload levels be monitored during the implementation of SBD, so that if necessary, changes to the system of work can be made to avoid any increase in risk.

As reported above, the average level of *frustration/stress* among PDOs in the SBD trial was higher than that reported for the current system (see footnote 1). Whether or not it remains at the observed levels once SBD is fully implemented will depend on how the process is

[2] As shown in Figures 1 and 2 of the Detailed Report below, ratings on all aspects of mental workload related to the SBD delivery process were substantially higher than for the current delivery process. Looking at *how much* higher, the biggest differences were for *frustration/stress* (6.0 for SBD versus 3.5 for current process), *overall effort* (6.5 versus 4), and *mental demands* (7.0 versus 4.5).

managed; if well managed, the levels would be expected to decrease substantially, to an extent that would not present any increased risk. If they remained at the levels measured during the trial, the risk of chronically elevated stress levels would probably increase, with resultant longer-term increases in risk of MSDs and other stress-related conditions and diseases (e.g. obesity, cardiovascular disease), as well as road accidents.

Read and Ride Behaviour

Following full implementation of the SBD process, the inherently greater complexity and related attentional demands of the SBD delivery process (entailing 'merging' of the separate bundles, as well as delivery) will continue to require more time per delivery point, compared with the previous process. This requirement is likely to decrease the risk of PDO 'read and ride' behaviour, which with the current delivery system is a well documented source of risk.[3] Provided that the SBD process is well managed, it therefore has the potential to improve road safety.

Consistent with the above, some of the PDO participants in the trial commented that 'read and ride' behaviour was less likely with SBD, and that this would be expected to improve road safety. However, they also commented that *some* PDOs are likely to try to read and ride even with SBD once they are fully up to speed with the new process, and that this would put them at *increased* risk relative to the present delivery process, because of the greater attentional demands of SBD. In this context, the issue of standard times that would be allocated for delivery once SBD is implemented was seen as very important by many of the PDOs, because of the implications for required work rates and therefore for road safety.

These PDO comments are supported both by more general research evidence and by expert opinions of the consultant team. They highlight the importance of managing the SBD process so that time pressures are minimised, and so that the likelihood of PDOs perceiving any possible *advantages* to be gained by reading while riding are also minimised.[4]

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[3] Incident report data illustrating the current extent of this risk was provided by Australia Post.

[4] For example, supervisors should investigate cases where PDOs consistently complete their delivery in less than the expected time without any reasonable explanation, and where warranted should take whatever steps are warranted to reduce the incidence of this if it is found to reflect 'read and ride' behaviour.

Fatigue

An important issue for many of the participating PDOs was the total time they would be expected to spend riding their motorcycle once SBD is implemented. They were concerned that this time might be longer than with the current delivery process, in which case some commented that fatigue levels would certainly be higher, with negative effects on road safety. This is a valid concern, given the evidence from this project that during the SBD trial, levels of fatigue were higher than with the current delivery process,[5] and the large amount of other research evidence linking fatigue with crash risk. However, for the reasons discussed in the mental workload section above, it is expected that levels of fatigue measured during the trial may well reduce following full implementation of SBD (depending on how well the process is managed).

It is concluded that when SBD is implemented, total time 'on the road' should initially be limited so that durations do not exceed current levels, and that analyses of data collected during the implementation process should quantify the relationship between this duration and risk indicators such as fatigue (e.g. *how tiring*), and *aches/pains*. On this basis, future policy concerning the maximum acceptable duration for total time on the road can be empirically determined.

More specific recommendations regarding the kind of monitoring required during SBD implementation are provided in the final section of this Summary Report.

Possible Effects of SBD on Risk of Musculoskeletal Disorders (MSDs)

Background to MSD Risk Assessment

There is a large body of research evidence illustrating that MSD risk can be strongly affected by a wide range of factors in addition to the physical demands of 'manual handling' that are conventionally the focus of risk management activities. For reviews of this evidence, see for example: Bernard et al (1997), Macdonald & Evans (2006), and National Research Council and Institute of Medicine (2001) – all of which are downloadable from the web (see links in the References section of the Detailed Report). In particular, see the model of MSD causal

[5] Mean rating for *Fatigue* was 6.9 for SBD delivery versus 4.8 for the current delivery process.

factors depicted in Figure 6 of the Macdonald & Evans report (page 24), which is reproduced here in Appendix E. (The whole document is downloadable from the SafeWork Australia website – see References)

As well as noting the multiple hazards affecting MSD risk, it is important to understand that many of these physical, organisational and psychological hazards can interact with each other in affecting MSD risk. It is therefore *not* appropriate to assess risk based simply on the assessments of each of a set of hazards considered in isolation from each other. For example, a given level of repetition, or a given level of biomechanical load, may each be acceptable (i.e. not unduly risky) when considered in isolation from each other, but *in combination* they may be unacceptably risky. Similarly, such levels may be acceptable when exposure is for a fairly brief period each day, but unacceptably risky when exposures are for longer durations. For these and other reasons, the kind of risk assessment process used to manage risks with less complex origins (e.g. risk of asbestosis, for which exposure to asbestos is the workplace hazard) is not appropriate when assessing MSD risk.

Conclusions concerning MSD risk in the present project are based on the above view, which has been formally endorsed by the International Ergonomics Association Technical Committee on Musculoskeletal Disorders.[6] However, our risk assessment procedures were constrained by the short time available for assessing physical demands of the delivery process.

Evidence from Video-based Analyses of SBD Physical Demands

It was beyond the scope of the present project to conduct video-based analyses of the current delivery process. More general information about the current process was available from informal observations, from briefings by Australia Post staff, and from the past experience of the senior consultant with the current PDO delivery process. However, conclusions concerning MSD risk in this section are based primarily on results from the various analyses of SBD physical demand hazards, with assessed risk levels based simply on the risk 'bands' inbuilt into the various assessment methods used. For the reasons outlined in the above

[6] The senior consultant on this project, Wendy Macdonald, is currently Co-Chair of that Committee, with specific responsibility for developing a 'toolkit' to promote more effective MSD risk management at workplace level.

Background section, these risk levels should not be interpreted in absolute terms; that is, they provide information on whether risk for conditions being compared are higher or lower than each other (*relative* risk), rather than level of risk on some *absolute* scale.

Bearing these limitations in mind, three aspects of SBD were identified as *possibly* presenting an increased risk of MSDs. These three aspects are outlined below, together with some possible options for risk reduction, in accord with the brief.[7]

Before summarising those three aspects, it must be emphasised that inclusion of suggested risk control strategies for each of the three aspects does *not* imply that SBD would necessarily be unacceptably risky if they are *not* implemented. Based on current evidence, it is not possible to specify the *extent* of the reported increase in risk for each of the three aspects below. It is possible that the increase might be relatively small, with no appreciable increase in numbers of reported MSDs, because the risk estimates are based on assessing only the subsets of MSD hazards addressed by the selected analysis methods.[8]

The three aspects of SBD that were identified as *possibly* increasing MSD risk are as follows.

(1) Relative to the present process, SBD requires more time to select mail at delivery points. Because of this, SBD requires more time to be spent with the head bent forward and hands/wrists manipulating items of mail. To some degree, this increased time spent in 'hazardous' manual handling activities at the delivery point might be offset by less time spent in such activities during mail sorting prior to delivery, since both tasks entail a high level of hand/arm activity. However, the extent of any such offset effect could not be assessed from the data available for this project.

Potential Risk Reduction Strategies

- One kind of strategy would be to limit the *time* for which PDOs are exposed to the adverse postures described in the above paragraph. For example, perhaps it would be possible to design PDO jobs so that the total time any individual spends in such

[7] The amended brief included the requirement that "any recommended additional controls" related to identified physical demands of SBD should be specified.

[8] Currently, there are no available MSD risk assessment methods that address most or all relevant hazards, although such a method is currently being developed at La Trobe University.

hand/arm activities (selecting mail from the front letter carrier; mail sorting) is not significantly greater than with the current process.

- Another kind of strategy would be to consider design changes to the motorcycle or its equipment in order to modify PDO postures so they are closer to a 'neutral' (risk free) position – for example, further changes to the design and/or positioning of the front letter carrier.[9] In practice, however, such modifications might be precluded by the need to comply with Australian Design Rules (ADRs) for motorcycles.

(2) The process of reaching back to into a pannier bag to retrieve another bundle of mail to replenish the front letter carrier is potentially hazardous. This occurs more frequently with SBD than with the current process, due to SBD mail bundles being smaller than current ones. Being smaller, the bundles are lighter, which to some extent might offset the increased frequency of hazardous back movements; however, the extent of any such offset effect could not be assessed from the data available within this project.

Potential Risk Reduction Strategies

- One kind of strategy would aim to minimise the velocities/accelerations entailed in this bending/twisting action of the trunk, since higher rates of movement are much more hazardous. To this end, all possible measures to reduce PDOs' motivation to rush through their round would be beneficial in reducing MSD risk (as well as reducing road safety risks as already noted).
- Another kind of strategy would aim to reduce the *extent* of trunk bending and twisting. Based on a biomechanical analysis of the task, this would be achieved by locating the next bundle of mail to be retrieved as far *forward* as possible, and as far *out* from the motorcycle as possible. Such changes would presumably require modifications to the design and/or placement of the pannier bags. If such a change were contemplated, it would be important to ensure compliance with ADRs.

(3) As noted in (1) above, SBD entails more PDO time at delivery points, so more time is spent supporting the weight of the stationary motorcycle. This imposes asymmetric loads on the back and lower body in ways that might possibly increase the risk of back injury.

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[9] All of the currently planned design changes had been fully implemented on the motorcycle used for the SBD delivery activities that were video-recorded, photographed, measured and analysed for this project.

Any such increase in risk would be expected to increase with *decreasing* height (i.e. least risk for tallest people).

Potential Risk Reduction Strategies

- One kind of strategy would aim to eliminate or reduce the need, when the motorcycle is stationary at delivery points, for PDOs (of all heights) to support its weight with their lower body. In principle, this could be achieved by modifying design of the motorcycle so that some kind of stand to support this weight would be activated by an easily executed action of the PDO, and retracted each time by another easily executed action. In practice, however, such modifications to the motorcycle might be impracticable – for example because of constraints imposed by motorcycle ADRs.
- Another kind of strategy would reduce the extent of the forces required to maintain the motorcycle upright by making it a requirement for PDOs to be above average male height. However, in a context where recruitment into this job may be increasingly difficult, such a strategy appears likely to be impractical.

Again it is emphasised that inclusion in this report of the above three sets of potential risk reduction strategies does *not* imply that the SBD process will be unacceptably risky if such strategies are not implemented (although of course any that are reasonably practicable *should* be implemented). This is because it is impossible to draw conclusions concerning *overall* MSD risk based simply on the risk associated with relatively small subsets of physical demand hazards (at least within the range of hazard severity levels found here), because overall risk is determined by a much larger and more varied set of hazards (see Appendix E).

It is therefore suggested that consideration of these three sets of risk reduction strategies could be deferred until further data are available from monitoring of the SBD process when implemented. If monitoring is implemented as recommended in the final section of this Summary Report, the resultant data would provide a more reliable indicator of actual MSD risk. This would constitute a better basis for decisions concerning which kinds of risk reduction interventions – if any – might be warranted.

Evidence from the Ratings Data

Some of the ratings documented during PDO interviews, referred to in the above section on

Road Safety, are also relevant to assessment of MSD risk. Most obviously relevant are the PDO ratings of *physical demands*. As expected, the average rating level was lower during the indoor component of PDO participants in the trial (3.7 for SBD, versus 4.2 or 4.4 for the current process depending on whether V-sort or Merging was being considered). For outdoor work, however, the average *physical demands* rating was higher for SBD (6.7) than for the current delivery process (4.5), although *physical demand* ratings were higher for SBD (6.7) than for the current delivery process (4.5).

Consistent with the above ratings, levels of fatigue (ratings of *how tiring*) for indoor mail sorting work were lower for SBD (3.4) than for the current process (4.5), but for outdoor work they were higher for SBD (6.9) than currently (4.8). Similarly, ratings of *aches and pains* related to indoor work were lower for SBD (3.1) than currently (3.5), but for outdoor work they were higher for SBD (6.0) than for the current delivery process (4.1).

Finally, stress levels can have a substantial effect on MSD risk, and as already reported in the Road Safety section above, ratings of *frustration/stress* were higher for SBD delivery than for the current delivery process.

These PDO ratings cannot be directly translated into differences in MSD risk levels – particularly since they were collected during the SBD trial rather than during and after its full implementation (for the reasons outlined in the Road Safety section above). Taken together, however, the patterns evident in these ratings further underline the importance of careful monitoring during SBD implementation.

Recommendations for SBD Implementation

(1) *Based on all of the information documented in this project, it is reasonable to proceed with implementing the SBD process, provided this process is managed and monitored in accord with the following recommendations.*

The implementation process will need to be carefully managed, with periodic monitoring of key risk indicators during *at least* the first year or so of the implementation process

(depending on how the process is staged), to enable early identification of potential problems and the proactive introduction of appropriate risk control measures if required.

Recommendations re SBD Management

(2) *To maximise the prospect of SBD reducing the incidence of PDO 'read and ride' behaviour sufficiently to deliver road safety benefits*, it will be important to manage the process so that time pressures experienced by PDOs are minimised, and so that the likelihood of PDOs perceiving any possible *advantages* to be gained by reading while riding are also minimised (e.g. see footnote 4).

(3) *To minimise the risk of PDO fatigue increasing to an extent that negatively affects road safety and/or MSD risk*, it would be desirable for total motorcycle riding time per day to be limited, at least during the early stages of implementation, so that durations do not exceed current levels. The advisability of permitting future increases in this duration should be assessed in light of empirical data gathered during the implementation process concerning the factors that affect PDO fatigue levels and the size of such effects.

(4) *To avoid PDOs being exposed to greater risk of upper body MSDs due to 'manual handling'*, their jobs should if possible be designed so that the *total* time any individual spends performing precise hand/arm activities (i.e. selecting mail from the front letter carrier; mail sorting) is not significantly greater than with the current process, at least during the early stages of implementation. The advisability of permitting future increases in this total duration should be assessed in light of empirical data gathered during the implementation process concerning the factors that affect PDO physical discomfort/pain, and the size of such effects.

Recommendations re Monitoring of SBD Implementation

(5) To support implementation of the above recommendations, it will be important to document and monitor a number of parameters at regular periods during the first year or so of SBD implementation.

Most importantly, rating scales similar to those used in the present study should be completed by regularly surveying PDOs. It is suggested that the most important scales

for this purpose will be: time pressure, attention, avoiding errors, frustration/stress, physical demands, how tiring, and physical aches/pains. To facilitate diagnosis of likely causes, ratings of aches/pains should be extended beyond the unitary scale used in this project, following a procedure that has recently been developed and validated by Macdonald and colleagues at La Trobe University.[10] The survey should also collect information from each PDO on the other (indoor) activities they usually undertake during a typical shift (e.g. mail sorting), and total duration of a typical shift.

In addition, some key parameters for each SBD delivery round should be documented so that these can be analysed in conjunction with PDO survey data to support achievement of recommendations (3) and (4) above. This would include, for each round, numbers of delivery points and related mail volumes, duration of the delivery process, and duration of 'dead' riding time.

(6) It would be desirable for key findings from analyses of the above data to be discussed by representative focus groups of PDOs, to help identify and explain likely causes of observed patterns, and to help in generating potential solutions for any problems that come to light.

[10] Publication of this research is in progress; further details can be provided on request.

DETAILED REPORT

1. INTRODUCTION

1.1 Background

Australia Post has been trialling a Separate Bundle Delivery (SBD) process of mail delivery. Instead of having a single set of mail sequenced in accord with the sequence of addresses to which it must be delivered, Postal Delivery Officers (PDOs) participating in this trial had two main sources of mail – 'sequenced' mail (sequenced by machine) and 'residue' mail (sequenced manually), plus unaddressed mail (no sequencing required). Currently, 'sequenced' and 'residue' mail is merged at some point prior to delivery, but with SBD the 'merging' occurs at individual delivery points along the route.

The SBD process reduces the required amount of manual sorting work (indoor work), but it necessarily slows down the process of mail delivery (outdoor work) because at each delivery point there is more than one source of mail to be considered, whereas previously there was just one.[11] This change raises the following questions:

- Does SBD increase the mental workload of PDOs?
- If PDOs' mental workload is increased, what are the OHS implications, if any?

The initial brief for this project was to answer the above two questions, with the main focus on changes to aspects of the outdoor work. Following the main data collection phase, Australia Post requested that the brief be expanded to include:

- assessment of ALL foreseeable hazards/risks, including the physical demands
- additional information regarding whether the physical demands of SBD are acceptable, and any recommended additional controls related to such demands.

This expansion of the brief necessitated collection of additional data on the physical demands of SBD outdoor work, to support detailed assessment of associated risks of musculoskeletal disorders (MSDs). It was understood that similarly detailed assessments of the physical

[11] See Hoffmann et al (1993) for an explanation.

demands of (a) SBD *indoor* work, and (b) the *current outdoor* (delivery) process, were beyond the scope of this project.

1.2 What is the 'Mental Workload' of PDOs?

The topic of 'Mental Workload' has been extensively researched by cognitive ergonomists.[12] They have established that one of the key factors underpinning the workload people experience while performing a particular task are the inherent limitations on the rate at which people can 'process' information.[13] As a task becomes more mentally demanding (requiring the processing of larger amounts of information), the rate at which people can work necessarily decreases.[14] In the present context, when the amount of information that has to be processed by PDOs delivering mail *increases*, they can avoid information overload by working more slowly, so that the *rate* at which they process information does not exceed their capacity and their mental workload is less likely to be excessive.

For the present purpose, mental workload is viewed as a multidimensional construct as defined in the International Standards Organisation (ISO) Standards on mental workload (ISO 10075-1, 1991; ISO 10075-2, 1994). Although referring to 'mental' workload, these Standards are explicitly intended to apply to all kinds of work, including work that would be seen as primarily physical in nature (see Nachreiner, 1995). It is this view of mental workload which underpins the most widely used method of measuring mental workload – the NASA Task Load Index (TLX; see Hart & Staveland, 1988; Tsang and Wilson 1997). The NASA-TLX has been well validated in a number of different contexts, and its multi-dimensional nature provides diagnostic value. The six standard scales of the TLX are: mental demand; physical demand; temporal demand (i.e. time pressure); effort expended; frustration/stress; 'own performance'.

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[12] In ordinary conversation, the term "workload" refers simply to the amount of work that has to be done, and "mental" workload implies that the workload relates to work that is mentally rather than physically demanding. However, within the domain of cognitive ergonomics (see http://www.iea.cc/01_what/What%20is%20Ergonomics.html) the term has a more technical meaning (see Appendix A for a little more detail).

[13] This rate has been quantified as approximately 2.5 'bits' (binary digits) per second e.g. see http://www.musanim.com/miller1956/

[14] This was the basis of earlier work for Australia Post to establish how target sort rates should vary to take account of different levels of information processing demands related to differing mail set characteristics – see Hoffmann et al (1993)

Macdonald and co-workers trialled and developed some adaptations to the above TLX scales for use within the Australian OHS context (see Macdonald, 2003). On this basis, and taking account also of the issues seen as most important in the current Australia Post situation, a set of rating scales was selected for use in the present study, as described in section 2.1 below.

1.3 What are the 'Physical Demands' of PDO work?

Physical demands of work which may be hazardous – particularly in relation to MSD risk – and which have potential relevance to PDO work, include:

- repetitive movements – repeating same actions every few secs or mins
- hold, push or pull things, using some force – particularly if vibration present
- twisted or awkward postures
- head or body bent forward
- twisting of the trunk
- standing in one position for extended periods
- sitting for extended periods – particularly if vibration through the seat
- use hands or fingers to hold or grip things with significant force or for extended periods
- make precise movements to place things accurately
- cold environment.

The above factors interact with each other, as well as with other types of hazard, including psychological and organisational factors, in their effects on MSD risk. It is therefore inappropriate to assess this risk based on consideration of any single hazard in isolation from others that may also be present. For example, a given level of repetitive movements (how highly repetitive), or a given level of adverse posture (how extreme the posture is), may each be acceptable when considered in isolation from each other, but *in combination* they may be unacceptably risky. Similarly, such levels may be acceptable when exposure is for a fairly brief period each day, but unacceptably risky when exposures are for longer durations. This issue is discussed further in Section 4.4 below.

2. WHAT WE DID

2.1 Method used to assess mental workload levels

Participating PDOs were asked to make a set of ratings on each of the following scales.[15]

1. how high are the *mental demands*?
2. how high are the *physical demands*?
3. how much *time pressure* do you feel? ("... that's *not* about how fast you work, because you might feel time pressure whether or not you're going fast; it's just about the time pressure you experience, for whatever reasons")
4. how much *overall effort* does it take? ("... taking everything into account")
5. how much *frustration or stress* do you typically feel? ("... whichever words you like to use")

   PLUS ...
6. how much do you have to *focus on avoiding errors*?
7. how much do you have to *pay careful attention* to what you're doing? ("... as opposed to working on auto")

8. how *tiring* is this?
9. what level of *physical aches and pains* do you typically have?

10. is *road safety* risk higher or lower with SBD? why?

Comparing the above scales with those of the standard TLX (section 1.2 above), it can be seen that the first five of the above scales are the same as the standard TLX ones, while the last of the standard scales – 'own performance' – was omitted. This omission was based on strong evidence (summarised by Macdonald, 2003) that in ordinary workplaces it is usually not useful to ask workers to rate the quality of their own performance within this kind of OHS or IR context. Instead of 'own performance', scale 6 above was added to obtain information on the perceived risk of performance errors. Also, scale 7 was added to focus in

[15] Appendix B shows details of each scale.

more detail both on the *nature* of mental demands (since the standard 'mental demand' scale relates to a concept that is quite abstract for most people).

Scale 8 ('tiring') and Scale 9 ('physical aches and pains') relate directly to the effects on individual workers of high workloads. They were added here because both the current and SBD processes impose significant physical demands, and overall MSD risk is substantial, as would be evident from inspection of Australia Post's injury claims.

The final question on road safety was asked in various forms (changing somewhat as the study progressed, in response to participants' answers). In some cases, participants rated levels of road safety; in others, they were simply asked whether in their view, road safety was likely to be better or worse with SBD. Reasons for their responses were explored in follow-up questions.

Interview procedure

The interviews were conducted by one or other of the two consultants on five days during late June and early July 2010 (dates specified in table below), in Queensland (Heathwood), New South Wales (Lakemba, Seven Hills), and Victoria (Seaford, Mount Waverley). Information obtained by interview was supplemented by that from informal observations of SBD trial participants performing their work.

Delivery Facility or Centre	Trial Commenced	Trial Concluded	Interviews for this project
Heathwood DF	10/ 05/ 2010	02/ 07/ 2010	23/ 06/ 2010
Mt Waverley DC	12/ 05/ 2010	16/ 07/ 2010	02/ 07/ 2010
Seaford DC	12/ 05/ 2010	02/ 07/ 2010	25/ 06/ 2010
Lakemba DC	31/ 05/ 2010	29/ 07/ 2010	14/ 07/ 2010
Seven Hills DF	04/ 06/ 2010	20/ 07/ 2010	29/ 07/ 2010

All interviews were in a completely private room (e.g. the manager's office with the door closed). At the start of each interview, one or other of the consultants introduced herself as from La Trobe University, working independently of Post. It was emphasised that no individually identifying details were being recorded, and that responses would be reported

back to Post at group level only, so that the ratings or comments of individual participants could not be identified. In addition to completing the formal ratings, participants were invited to give their own views on any aspect of the trial and/or its future implementation, and comments of particular interest were recorded.

Prior to the formal ratings, participants were asked about their personal experience of each of the work processes. For indoor work these were v-sorting, merging, and SBD; and for outdoor work they were the current process, and SBD. Individuals who had little or no experience with either merging or v-sorting were not asked to provide ratings for those. At Lakemba, no one was asked about 'merging' since this had not been used there.

For each of the three work processes, indoor and outdoor components of the work were rated separately, where appropriate. At Heathwood, which was the first place visited, details of scale wording were amended during the course of data collection to make them more easily understood and relevant for PDOs, which resulted in some minor differences between results from that location compared with the other four locations.

2.2 Methods used to assess physical demands

The primary purpose of assessing the physical demands of SBD outdoor work was to provide a more detailed assessment of their contribution to MSD risk. However, assessment of MSD risk is a complex and inexact process, and even when focus is confined to the effects of physical demand factors (sometimes referred to as 'manual handling' hazards), assessment is difficult because (a) different aspects of physical demand can act both interactively and cumulatively in their effects on risk, and (b) no existing risk assessment method is designed to do this – most are very narrowly focused, and none provides comprehensive coverage of MSD hazards.

In selecting a set of analysis methods to assess MSD risk due to physical task demands, the aim was to assess as many of the relevant aspects of physical demand as possible within the limited time available. Selection of these aspects was based on: reports of Australia Post's prior risk assessments; observations of the SBD delivery process during the trial; and

discussions with Australia Post staff, including those involved in designing/developing SBD equipment used on the motorcycle and PDOs participating in the SBD trial.

The main methods used were:

- Rapid Upper Limb Assessment (RULA) – used to assess MSD risk associated with twisted or awkward upper body postures. (However, note that RULA deals only with *static* postures.)
- The OCRA Checklist – used to assess MSD risk associated with repetitive movements. This method also takes some account of risk due to: holding or gripping; precision requirements; presence of vibration; and cold environment.
- The 3D Static Strength Prediction Program (3DSSPP) – the main method used to assess MSD risk from the biomechanical loads of some postures, and from the forces entailed in holding, pushing or pulling actions. This was supplemented by the OVAKO Working posture Analysing System (OWAS) to further assess whole body postural demands.
- Additional calculations of (bio)mechanical forces were used to estimate required supporting/restoring forces exerted by PDOs when astride a stationary motorcycle at a delivery point.

These methods is quite narrow in their focus, and only one of these methods – the OCRA Checklist – takes any account at all of exposure *duration* when assessing the extent of risk presented by the specific hazards it addresses. In fact, to do this adequately is very complex and extremely time-consuming.

Data used in all of the above methods were obtained from video-recordings and still shots of three different people, intended to represent PDOs of short, average and tall stature.[16] They were recorded when astride a fully loaded stationary motorcycle, and when delivering mail using the SBD process. In addition, various aspects of the physical task demands associated with performing this task were directly measured (e.g. relevant forces), and some additional

[16] The request to Australia Post was for a 'tall man' (Subject 1 – S1), someone of around 'average height' (Subject 2 – S2), and a 'short woman' (Subject 3 – S3). As it turned out, S1 was 196cm which is close to the 100th percentile; S2 was close to the male average (176cm – approximately 53rd percentile); but rather than being short, S3 was considerably above the average female height (169cm, approximately 70th percentile).

data on factors not amenable to direct observation within the project timeframe were provided by Australia Post (e.g. times from Modapts analyses of the SBD delivery task, shift durations, etc).

All of the above formal methods (i.e. all except the basic biomechanical calculations) quantify risk in terms of scores which are then sub-divided into four or five different categories from 'acceptable' risk through to the highest level of risk *from the subset of hazards assessed.* However, the terminology used to describe these categories should not be taken literally. For example, the second lowest of the five OCRA risk categories is "Borderline"; the second lowest of the four RULA categories is "Investigate further"; the second lowest of the four OWAS categories is "Corrective actions required in the near future"; while the 3D SSPP score as the percentage of people of a specified height and weight (male and female separately) who could exert the required force, separately for each of six body parts, and so does not indicate injury risk *per se.* Further, there is remarkably little empirical evidence demonstrating the validity of these or any other such methods in terms of their ability to predict actual MSD risk in specific situations. The OWAS and RULA risk categories are based simply on discussions among groups of experts involved in their development. In the case of the OCRA Checklist, its developers claim some empirical evidence of its validity, but very little has been published to establish this reliably.[17]

In light of the above, the differences in risk associated with the varying sets of hazards assessed by these various methods must be taken as indicating ordinal differences at best. They do not indicate the extent or absolute level of risk in any quantitative sense.

[17] The ManTRA method used by Australia Post to assess risk related to physical demands was developed initially for use by workplace inspectors working for an Australian OHS regulator. It is not comprehensive in its coverage of MSD hazards, and has not been empirically validated in relation to actual MSD levels.

3. FINDINGS

3.1 Mental Workload Levels

Mean ratings (out of 10) for each of the workload constructs are shown in Figures 1 and 2 below for Indoor work and Outdoor work respectively. Results for each location separately are shown in Appendix C.

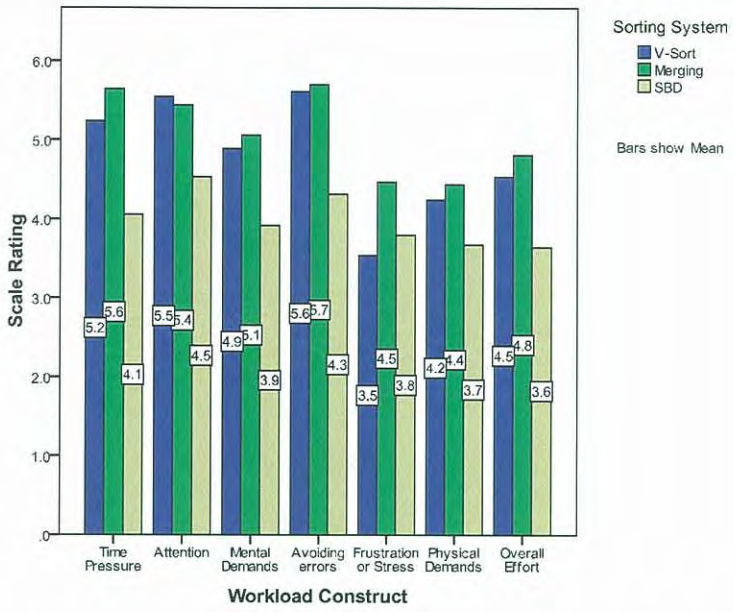

Figure 1. INDOOR WORK: mean ratings for each of the workload constructs (1 to 7 on page 12 above), showing each of the three work processes separately within each construct.

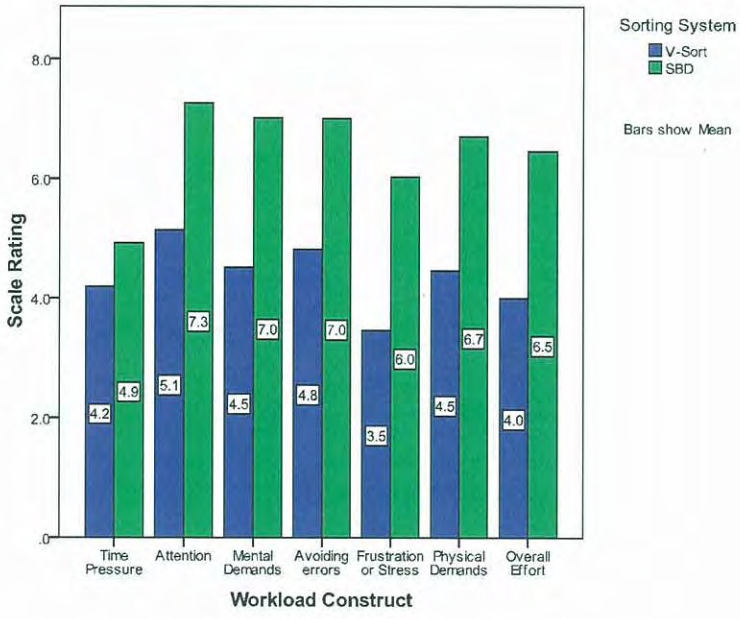

Figure 2. OUTDOOR WORK: mean ratings for each workload construct, showing ratings for the current and SBD delivery processes separately within each construct.

Overall, it can be seen that mental workload was highest for the SBD delivery process (outdoor work), compared both with the current delivery process and with all indoor work. Comparing the different work processes, for *indoor* work mental workload was *lowest* with SBD, but it was *higher* with the SBD delivery process than the current one.

Indoor Work

Figure 1 (indoor work) shows that mental workload for SBD indoor work during the trial was clearly lower than for the other two work processes: ratings were lowest for SBD on all workload constructs except *frustration/stress*, for which V-sort was the lowest.

The overall highest rated aspects of indoor workload were the requirements to *be careful to avoid errors*, and to *pay careful attention*. The overall lowest ratings were for *frustration/stress* and *physical demands*.

Outdoor Work

In contrast to the above results for indoor work, all ratings for the SBD delivery process were substantially higher than for the current delivery process. The aspect of mental workload rated highest was the requirement to *pay careful attention*, followed by *mental demands* and the requirement to *be careful to avoid errors*. Looking at how *much* higher ratings were for SBD compared with the current process, the biggest differences were for *frustration/stress* (6.0 for SBD versus 3.5 for current process), *overall effort* (6.5 versus 4), and *mental demands* (7.0 versus 4.5).

A problem raised by many PDOs was that of mis-sorts, which they attributed to the machines sequencing mail for delivery – replacing work previously done manually. With SBD, such mis-sorts are not detected until during delivery and this problem would undoubtedly have increased levels of *mental demands*, *be careful to avoid errors* and, for some individuals, *frustration/stress*. This project did not document data on the actual prevalence of mis-sorts, but the perceived problem certainly appeared to contribute substantially to PDO mental workload during the SBD delivery (outdoor) process.

It is noteworthy that for both the current and SBD delivery processes, ratings of *physical*

demands were not among the highest, relative to other aspects of mental workload. Issues related to the physical design of equipment (such as the front letter carrier – particularly during rain) were widely commented on by participants in this study, but at the time of these interviews the primary focus of the project was on PDOs' mental workload, so these matters were not explored further in these interviews.

3.2 Ratings of Tiredness, Aches and Pains

When mental workload levels are higher, it is expected that people will experience the work as more tiring. This was rated by scale 8.

Mean ratings are shown in Figure 3, separately for the three indoor work processes. The rating for the SBD delivery process is labelled as such alongside SBD indoor work, but the rating for the current delivery process is shown alongside the 'V-sort' indoor work rating.

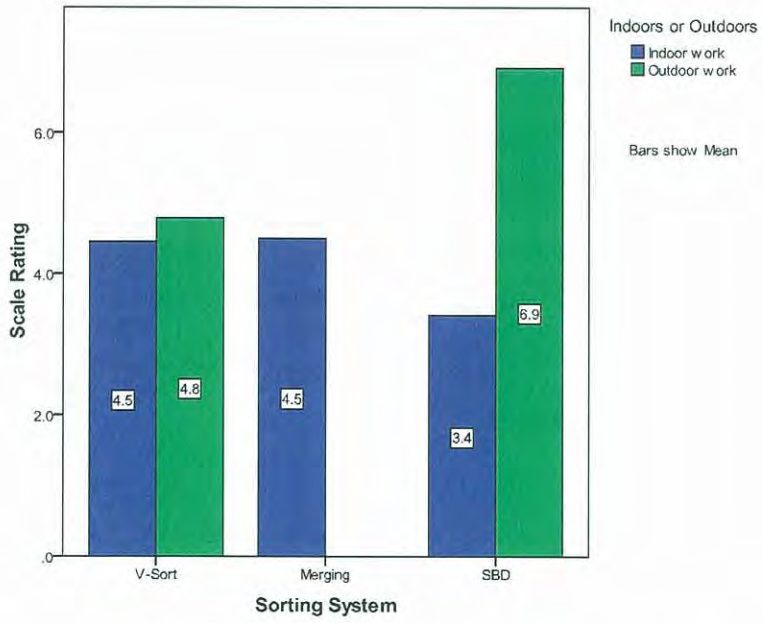

Figure 3 'HOW TIRING?': Mean values of ratings for scale 8. (See above two paragraphs for a description.)

It can be seen that the mean tiredness ratings for current indoor work (v-sort, merging) were the same as each other (4.5), and very similar to the rating for the current delivery process (4.8). In contrast, there was a large difference in tiredness ratings for SBD indoor versus outdoor work, with indoor being lower (3.4) and outdoor being higher (6.9) than ratings for

current work processes.

Levels of *aches and pains* were rated by scale 9, which was included because high levels of mental workload can cause increased levels of physical aches and pains – particularly if the work also imposes some physical demands as in the present case. Mean ratings are shown in Figure 4, broken down in the same way as for scale 8 (*how tiring*). Not surprisingly, the patterns in Figures 3 and 4 are similar, with *aches and pains* ratings being highest for SBD outdoors, and lowest for SBD indoors, consistent with the workload ratings reported above.

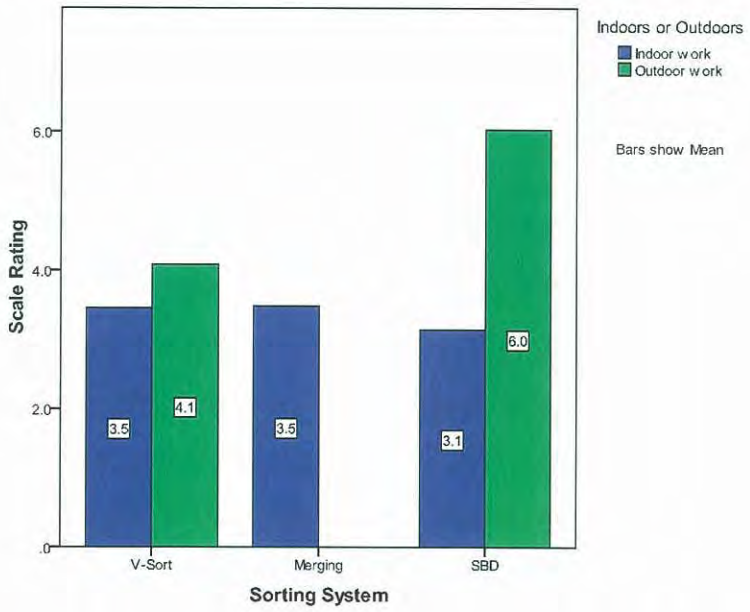

Figure 4 'ACHES & PAINS': Mean values of ratings for scale 9. (See the above two paragraphs for an explanation.)

3.3 Participant views on SBD and Road Safety

The final scale (number 10) concerned effects of SBD on road safety, which is not part of mental workload. This scale was used to tap participant views on the potential advantages and disadvantages of SBD for road safety, since this topic is of central importance to PDOs' OHS.

There was no clearly perceived difference in road safety between the current delivery process and the SBD process: the mean road safety rating for SBD was 5.0, while for the current process it was 5.3. Of greater interest are the kinds of additional comments people made.

The most commonly expressed reason for SBD being *safer* was that the process virtually enforces a stop at each delivery point, and makes it much more difficult to read and ride. On the other hand, a commonly expressed reason for SBD being *less* safe was that it requires more concentration on the mail (as opposed to the road traffic environment). Another common comment was that SBD is more tiring (for a variety of specified reasons), which was seen as making PDOs more error prone and therefore at greater risk of involvement in road accidents. Higher fatigue levels with SBD were often seen as due, at least in part, to spending longer on the road during the trial, and it was widely believed that if/when SBD is implemented, at least some PDOs would be expected to routinely work longer hours on the road than currently.

One person said: "Road safety is better [with SBD] because you *can't* read and ride. But if you *did* attempt it, safety would be worse [than with the current delivery process]". This was a common view, and many of those expressing this view linked it to the importance of the time allocated to complete delivery, once SBD is implemented. There was widespread concern that, while there was relatively little time pressure *during the trial*, this situation would probably change once the process was implemented. In that case, they expected that road safety would deteriorate because at least some PDOs would respond to increased time pressure by trying to read and ride, despite the greater difficulty and risks of doing this with SBD.

It can be seen that a common underlying concern related to SBD impacts on road safety was that of time on the road once the new process is implemented – in terms both of time allocated for delivery related to the required *work rate*, and the *total time* that people would be required to spend on the road.

3.4 Physical Demands and Related Risk Levels

The key differences between SBD and the current delivery process occur at delivery points, where required actions are somewhat different, and with SBD PDOs spend more time at each point. Accordingly, analyses focused on activities at this stage of the delivery process.

Four different methods were selected to analyse hazards and assess risks of the SBD process, as described in section 2.2 above. Each method was applied using SBD performance samples from video-recordings and photos of three people of different heights (referred to in Sections below as Subjects A, B and C).

Conclusions from each analysis method are summarised below, and some further details are presented in Appendix D.

RULA – the Rapid Upper Limb Assessment (RULA) method

RULA was selected as the most appropriate method for assessing risk due to upper body postures when seated on the motorcycle at delivery points. In accord with specified RULA procedures and criteria, the most hazardous postures were selected for analysis. These were the postures entailed in:

- selecting letters to be delivered at that point ('Selecting')
- leaning over to place selected items into the letter box ('Placing')
- reaching back into a pannier bag to obtain another bundle of mail ('Reaching').

RULA categorises postures into four different risk levels, described in terms of the urgency of risk control action.[18] These four categories are:

Category 1: Acceptable (Scores of 1 or 2)

Category 2: Investigate further (Scores of 3 or 4)

Category 3: Investigate further and change soon (Scores of 5 or 6)

Category 4: Investigate and change immediately (Scores of 7 or higher).

[18] The wording of these RULA risk categories should not be taken literally. As already explained, there is no valid basis for inferring levels of *absolute* MSD risk from assessment of such an incomplete set of risk sources.

For the different performance samples analysed, results were very similar at the 'Selecting' stage; highly variable at the 'Placing' stage, and somewhat variable at the 'Reaching' stage, as outlined below.

- 'Selecting': *Category 2 – Investigate further* (scores from different performance samples varied from 3 to 4).
- 'Placing': Most scores were *Category 3 – Investigate further and change soon* (scores varied from 4 to 6, so some were Category 2). High scores here were primarily due to very low or very high letterboxes, or boxes not on the property boundary so requiring extended lateral reach. This was not observed with great frequency, but the sample was a small one. Clearly, measures to encourage more PDO-friendly placement of letterboxes would reduce this source of risk. However, it is no worse with SBD than with the current delivery process.
- 'Reaching': *Category varied from 3 –Investigate further and change soon* (scores varied from 5 to 6). The highest score was for the tallest Subject (close to 100th percentile in height).

For two of the above three stages there are differences between SBD and the current delivery process. With SBD, 'Selecting' takes longer, and might possibly be associated with higher demands on the hands and wrists,[19] and 'Reaching' occurs more frequently. Since some risk was present for both these stages, it can be concluded that implementation of SBD might increase the injury risk associated with the postures assessed by RULA. However, the *extent* of such an increase cannot be predicted.

The OCRA Checklist

The OCRA Checklist is the most appropriate of currently available methods for assessing MSD risk associated with repetitive movements of the hands or arms, as required of PDOs. As well as assessing extent of repetition, it takes some account of various other factors known to influence risk, including: upper limb postures (not in great detail); holding or

[19] Comparison of these demands for SBD versus the *current* delivery process was beyond the scope of this project, since it would have entailed much more extensive sampling of *both* processes. However, it appears unlikely that any such difference is substantial, particularly since information from the PDOs interviewed did not identify this as a significant issue.

gripping force (low levels only); precision requirements; presence of vibration; degree of external pacing; and cold environment.

This method results in an overall categorisation of risk into one of five categories:[20]

Acceptable (scores up to 7.5)

Borderline (scores from 7.6 to 11)

Unacceptable – low (scores from 11.1 to 14)

Unacceptable – moderate (scores from 14.1 to 22.5)

Unacceptable – extreme (scores 22.6 and above).

Some sub-scores are simply added to the total score, while others are weighted in accord with the proportion of time they represent within the whole activity. For the purpose of these analyses, the 'whole activity' was taken to be all outdoor work, comprising the following four components:

- 'dead' riding (from the mail centre to start of the delivery round and back again after finishing the round)
- riding from point to point through the round
- selecting and placing mail into a letterbox (corresponds to 'Selecting' and 'Placing' in the RULA analysis)
- replenishing the front letter carrier with new bundles of mail from the pannier bags (corresponds to 'Reaching' in the RULA analysis).

It was assumed that the other, indoor work performed by PDOs during a typical shift consists mainly or entirely of repetitive work (as defined by OCRA criteria) such as mail sorting.

Key findings were that risk due to the hazards assessed by this method was categorised as *Unacceptable – low* for both the current and the SBD delivery processes. The OCRA Checklist score for SBD was 11.3, which was marginally lower than the score of 11.6 for the current process.

[20] As with RULA, the wording of these categories should not be taken literally. Although OCRA assesses a wider variety of 'manual handling' hazards than does RULA, it is still very far from comprehensive in its coverage.

3D SSPP – the 3D Static Strength Prediction Program

As described above, RULA assesses seated posture, as appropriate here, but focuses mainly on risk related to *forward* bending of the trunk, taking relatively little account of lateral bending or twisting and no account of bending backwards, while OCRA focuses on repetitive work using the arms and hands, which is relevant in the present case, but takes no account at all of trunk posture.

Neither of these two methods adequately addressed the potential risk associated with reaching back into the pannier to retrieve a bundle of mail to replenish the FLC, which entails substantial lateral bending and twisting of the trunk, and in some performance samples also entails *backward* bending of the trunk (more often observed for shorter people, and more often when the bag is emptier). For this purpose, the 3D SSPP was seen as possibly suitable. This is a widely used method for assessing MSD risk associated with forceful lifting, pushing, pulling or lifting actions and related whole body postures. In the present case, however, the loads being lifted were light, which cast doubt over its suitability. In fact, accurate modelling of the posture in question (reaching back to a pannier bag) was found to be not fully achievable, due to limitations in the 3D SSPP software program. Based on results for the nearest achievable posture, no significant risk due to associated biomechanical load was identified – primarily due to the light loads being lifted.

The OWAS method of assessing posture-related MSD risk was then trialled.[21] This method specifies four risk levels for trunk posture, the highest of which is when the trunk is both 'bent' (regardless of the direction of bending) and 'twisted'. The trunk is both bent and twisted in the present case so this method was considered for use here. However, while OWAS includes trunk bending and twisting it takes no account of the *extent* of either of these; also, the scores it produces are strongly influenced by postures of the arms (taking account only of whether or not arms are above or below shoulder height) and legs, weighted by the load being handled (very low in this case). A quick application of OWAS to performance samples from the shortest subject (for whom trunk postures while reaching back into the pannier bag were worst) produced scores in the OWAS 'Action Category' described

[21] For information on the OWAS method, see Mattila M, Vilkki M. OWAS methods. In: Karwowski W, Marras WS, editors. The Occupational ergonomics handbook. Boca Raton, FL, USA: CRC Press; 1999. p. 447–59.