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To what extent does body height affect the use and satisfaction of electrically-assisted bicycles for postal purpose?☆

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ABSTRACT

To investigate to what extent body height affects the use and satisfaction of electrically-assisted bicycles (EB) among postal workers, 1115 EB users filled in a questionnaire and 28 postal workers were observed during their distribution round. We aimed to provide a framework to estimate the possible effects of providing multiple frame sizes to postal workers. Although the body height of postal workers affected how they reached for mail and delivered it, it hardly affected their satisfaction with the current EB. Accessibility of the front carrier seemed to be the main issue that could be coped with by providing different frames. Ironically, postal workers for whom the front carrier was most accessible (tallest group) reported the highest physical load. The relevance of these results with respect to the availability of multiple frame sizes and other changes to the EB that might be beneficial from an ergonomic point of view is discussed.

1. Introduction

The bicycle has been an important tool in the delivery of mail for a long time. Compared to cars, bicycles are cheap, easy to use, and environment-friendly. Furthermore, compared to delivery by foot, the use of bicycles allows postal workers to take more mail and move faster. However, the daily delivery of mail by bicycle can be very demanding (Theurel et al., 2008). On busy days postal workers often have to deliver more than 130 kg of mail and cover up to 25 km.[1] In doing so, their average power output is approximately 185 W, with peaks exceeding 400 W (Theurel et al., 2012). Therefore, postal companies have been looking for ways to reduce the physical workload without reducing the amount of mail to be distributed per postal worker.

Motorbikes are often used for longer postal rounds. However, postal operators are reluctant to switch bicycles for motorbikes, mainly because the increased risk of accidents in urban traffic (Daniello and Gabler, 2011; NHTSA, 2007; Pai, 2011). Recently, electrically assisted bicycles (EBs) have been gaining popularity, not only for commuting and recreation, but also as a postal vehicle. Although the crash risk with EBs has been found to be higher than with normal bicycles, injuries were not more severe (Schepers et al., 2014). Similar to accidents occurring by foot (Bentley and Haslam, 2001; Norlander et al., 2015), bicycle accidents most often occur due to slipping.

In Belgium, the largest postal operator (bpost) has been using EBs for some years and wants to increase the share of EBs among the vehicles used for mail delivery. However, an EB for postal service has different needs than one for recreational use. Since these vehicles are used every day, whatever the weather conditions, and need to carry about 40 kg of mail, EBs for postal service need to be 'heavy duty'. Therefore, these EBs already have a reinforced frame and battery.

Furthermore, postal workers use their EB in a very different way than recreational EB users. Only during a short period of the working day, the postal worker actually 'cycles' for multiple consecutive minutes. In contrast to recreational use, most of the displacements are only a few meters (to the next mailbox). Pilot observations showed that these displacements are made by biking very briefly, by peddling, or by walking with the bike. Moreover, the mail has to be taken from the front carrier at almost every mailbox (see also Fig. 1). Therefore, a postal worker does not spend most of his time 'cycling' with the EB, but rather uses the EB as a 'tool' to carry post. Due to these constraints to

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Fig. 1. The current electrically assisted bicycle of bpost, which was introduced approximately six years ago. Front carrier can hold 1 bag, rear carrier can hold 2 full bags and 6 empty bags of mail.

the mail-delivering task, the postal EB has specific requirements, such as a low standover height and an accessible front carrier. Furthermore, in contrast with normal usage of an EB, the saddle of a postal EB is usually very low to facilitate stopping and starting, easily getting on or off the saddle, and allowing the postal worker to stand on both feet when the EB is standing still. Currently, the EB design of bpost already takes into account these important aspects of the job.

Nevertheless, there is still room for improvement of the quality and user friendliness of EBs for postal service. An important issue that bpost wants to address in the future is the lack of multiple frame sizes. Adapting the size of working tools to the anthropometry of the workers has previously been suggested to have a considerable impact on worker productivity, comfort, occupational health and safety (Das and Sengupta, 1996; Dewangan et al., 2008; Vieira and Kumar, 2004). Furthermore, it is widely acknowledged both in literature and within bpost that a correctly sized bicycle is important part of bicycle ergonomics (De Vey Mestdagh, 1998; Silberman et al., 2005). Unfortunately, due to a multitude of reasons (e.g. logistic, financial, uncertainty of impact …), bpost currently offers only one bicycle frame size to its employees. As multiple postal workers have already reported that the current EB is unfit for their posture, some EBs have been adapted, but this only consisted of lowering the minimal saddle height.

For city bicycles, and especially for racing bicycles, multiple fitting systems have already been developed and some posture studies have been carried out (Christiaans and Bremner, 1998; Laios and Giannatsis, 2010). These studies showed that correct bicycle fitting can reduce injuries, and increase comfort and cycling efficiency (De Vey Mestdagh, 1998; Silberman et al., 2005). Unfortunately, due to the specific constraints of the mail-delivering task, fitting a postal bicycle in the same way as a racing or city bicycle would not be preferable. For example, with a racing bicycle the saddle should allow an almost fully extended leg when at the bottom of the pedal stroke (Neuss, 2007). As was mentioned earlier, postal workers prefer to be able to have both feet touching the ground while seated to facilitate starting and stopping, and to keep the loaded EB in balance.

Knowing the possible benefits of properly sized working tools for employees, bpost is considering to offer multiple frame sizes to their postal workers. However, due to the unique way that EBs are used in a postal context, it remains uncertain if offering multiple frame sizes will have a large impact on the satisfaction and usage of the EBs for postal purpose. Therefore, the current study investigates to what extent body height of postal workers affects the use and satisfaction with the current EBs. In doing so, we aim to provide a framework for bpost to estimate the possible effects of providing multiple frame sizes to its postal workers. Furthermore, insights in how the EBs are used by postal workers also allows them to better describe the needs of postal workers to EB manufacturers.

2. Methods and analyses

The use and the evaluation of the EBs were studied in two ways. First, a questionnaire was distributed among all EB users of the company. In general, this questionnaire conducted an evaluation of the EB by its users, and questioned how the EB was used. Secondly, EB users were filmed during a full postal round to analyse the movements made during the delivery of mail. Both the questionnaire and the observation aimed to assess the use and the evaluation of EBs used for the delivery of mail in the major Belgian postal operator 'bpost'.

2.1. Pilot

To get familiar with the work of postal workers, and to have a first impression on their views on the current EB used at bpost, six postal workers were followed on their daily round by one of the researchers. During these rounds informal conversations about the EB and the work of a mailman/woman were held. Information from these initial observations and talks was used as a starting point to develop the questionnaire and the observation protocol.

Next to the general use and satisfaction with the current EB, three of the most recurring actions of the postal worker were selected for closer investigation in both the questionnaire and the live observations. These were: 1) reaching for mail in the front carrier, 2) delivering the mail in the mailbox, and 3) moving to the next mailbox.

2.2. Questionnaire

The questionnaire contained six broad categories of questions: 1) characteristics of the subject, 2) evaluation of the EB, 3) evaluation of postal actions, 4) evaluation of working environment, 5) physical complaints, and 6) other. Most questions were multiple choice with four options, and open questions provided the possibility to give suggestions to improve the EB, working process with EB, or other. This four-point scale was preferred to the standard five-point Likert scale to avoid excessive 'neutral' responses (Garland, 1991; Krosnick, 1991; Krosnick et al., 2001).

A draft version of the questionnaire was reviewed by staff of bpost, and by a panel of researchers not directly involved in the research. Four post office staff members, including one postal worker, performed a final review prior to launching the questionnaire. A Dutch and a French version of the questionnaire was available online and on paper in the local post offices for all EB users of bpost. The questionnaire took about 30 min to complete, and was available for 6 weeks. In total 1116 EB users of bpost completed the questionnaire. This corresponds to roughly 62% of all EB users within this company.

For the purpose of the current study, questions from the category '4) evaluation of working environment', and '6) 'other' were left out of the analysis since these questions concerned general issues for the postal worker, not directly related to the use of the EB. In "2) evaluation of the EB" a general satisfaction score on 10 was asked for the current EB with '1' being very bad, and '10' being very good ("*how would you rate the current e-bikes to carry out your job as a mailman/woman?*"). Furthermore, the balance, comfort, agility and manoeuvrability had to be rated on a four-point scale (bad – rather bad – rather good – good). The functional quality of multiple components of the bicycle (e.g. brakes, tires, handlebar, …) were also scored with the same four-point scale. Finally, EB users were asked whether they would prefer less or more frame sizes, or if there were enough.

In "3) evaluation of postal actions", the frequency of three key actions during the postal round was questioned. These three evaluated actions were 'how mail is taken from the front carrier' (4 ways), 'trunk position during the delivery of mail' (8 positions), and 'how the