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Transition to a cyclable city: Latent variables affecting bicycle commuting

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ABSTRACT

An understanding of the key factors influencing bicycle commuting is essential for developing effective policies towards a cyclable city. This paper contributes to this line of research by proposing a methodology for including cycling-related indicators in mobility surveys based on the Theory of Planned Behaviour (TPB), and applying an exploratory factor analysis (EFA) to evaluate the structure of latent variables associated with bicycle commuting. The EFA identified six cycling latent variables: *Lifestyle*, *Safety and comfort*, *Awareness*, *Direct disadvantages*, *Subjective norm*, and *Individual capabilities*. These were complemented with a latent variable related to habit: *Non-commuting cycling habit*. Statistical differences and regression analysis were applied with the cycling latent variables. The study also includes the relationship between objective factors and bicycle commuting, which reveals minor associations. This methodology was applied to the "starter cycling city" of Vitoria-Gasteiz (Spain). The results confirm that in this context – in transition to a cyclable city – safety and comfort issues are not the main barriers for all commuters, although more progress needs to be made to normalise cycling. A set of customised policy initiatives is recommended in the light of the research findings, including marketing campaigns to encourage non-commuting cycling trips, bicycle measures to target social groups as opposed to individuals, bicycle-specific programs such as "Bike-to-work Days", and cycling courses.

1. Introduction

Problems of sustainability in urban transport are well known and very common in developed countries. The public policies enacted to tackle them have focused mainly on promoting public transport and non-motorised commuting modes – including cycling – through policy documents such as the Green Paper on Urban Mobility (European Commission, 2007). In the last decade many cities in Spain have developed bicycle mobility plans aimed at increasing bicycle share, and the corresponding measures are already underway. Recent increases in cycling demand (Monzon and Rondinella, 2010) indicate that Spanish cycling levels are progressing adequately, although still in the early stages. One indication of this is the lack of information on cycling, as this is not generally included in household mobility surveys.

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In order to develop effective cycling policies it is essential to understand the key factors influencing bicycle commuting. Increased efforts have been made in both policy-making and academic research. Variables such as time and cost are not sufficient to explain why cyclists choose this mode of transport, and a wide array of variables – including latent variables – are currently under study using a variety of methodologies. Latent variables are not observed by the researcher and must be inferred from other observable variables called indicators – usually responses to attitudinal or perceptual survey questions – and require specific analysis techniques. Previous studies using a range of methodologies have identified cycling latent variables as influential in the decision to choose cycling. This is an active research field due to the complexity of latent variables.

This paper contributes to this line of research by focusing on commuting, and proposing cycling-related indicators based on the Theory of Planned Behaviour (TPB) (Ajzen, 1991) for their inclusion in mobility surveys. It also evaluates the structure of the latent variables that influence bicycle commuting using exploratory factor analysis (EFA). Statistical differences for cycling latent variables were determined between bicycle commuters and other modes, showing medium and high associations. These variables were also used in a regression analysis to explain bicycle commuting choice. The study also defined the bicycle commuter profile by analysing the relationship between certain objective factors and bicycle commuting. This methodology was applied to Vitoria-Gasteiz (Spain). According to Dufour (2010) this is a "starter cycling city" with a bicycle share of 6.9% (Council of Vitoria-Gasteiz, 2015) – the highest in Spain in 2011– and with moderate cycling conditions due to a favourable transport policy over the last decade. However, it has continued working to improve its bicycle use. Vitoria-Gasteiz can therefore be said to be in transition to a cycling city. The results confirm that safety and comfort issues are not the main barriers for all commuters, but more progress needs to be made to normalise cycling. The results also support the recommendation of a wide array of policy initiatives.

The paper is organised as follows. The conceptual model and literature review are presented in the next section. The methodology of the paper is described in the third section. The fourth section contains a description of the context and the data collection process. The empirical application is described in the fifth section, which is further divided into two subsections. The first contains the analyses of a number of traditional objective factors (socio-economic and household characteristics, mode availability, and trip characteristics). The second determines the cycling latent variables, analyses their differences among different types of commuters and shows the regression analysis. The last section contains some policy recommendations and conclusions.

2. Conceptual model and literature review

This study focuses on commuting trips and applies the Theory of Planned Behaviour (TPB) (Ajzen, 1991) as the conceptual framework for measuring cycling indicators – defined here as perceptions of cycling characteristics – in order to extract the latent variables for the study. This is a well-known and widely supported psychological attitudinal theory in studies relating to behavioural decisions. The TPB states that attitudes towards a behaviour, subjective and descriptive norms, and perceived behavioural control (PBC) combine to shape an individual's behavioural intention and final behaviour. According to the TPB, attitude towards a behaviour is "the degree to which performance of the behaviour is positively or negatively valued"; subjective norm refers to "the perceived social pressure to engage or not to engage in a behaviour"; descriptive norm is related to "perceptions of what others are doing"; and the PBC is considered as "people's perceptions of their ability to perform a given behaviour".

This study is part of a research work using the TPB, as it analyses how changes to infrastructures and transport policies may affect attitudes and other psychological constructs, and how these may in turn affect the decision to begin commuting by bicycle. The TPB has also been successfully applied in a number of studies on bicycle use during the last decade and more recently. However, taking into account criticisms of this theory – namely that strong habit reduces the influence of TPB constructs – we have extended its application by including habit. Previous studies have shown that habit has a significant impact on bicycle use (Forward, 2004; de Bruijn et al., 2009; Heinen et al., 2011; Muñoz et al., 2013).

Most of the studies on cycling using the TPB focused on modelling applications. Some used the "intention" to choose the bicycle as the dependent variable. In studies using regression analysis, the extended version of the TPB in Forward (2004) explained between 47% and 78% of variance in intention to bike in four different cities with different levels of cycling. The TPB regression model in Eriksson and Forward (2011) explained 45% of variance in intention to use a bicycle for daily trips. Sigurdardottir et al. (2013) used a structural equation model and found that adolescents' cycling intention to commute by bicycle as adults was related to a positive cycling experience, willingness to accept car restrictions, negative attitudes towards cars, and a bicycle-oriented future vision; and was negatively related to car ownership norms. Lois et al. (2015) recently extended the TPB model to predict cycling commuting intention by including social identity, and their logistic regression model revealed that the psychosocial variables alone predicted 32% of the variance in car users' intention to start commuting by bicycle.

Other studies predicted the behaviour rather than the intention in the TPB framework. The binary logistic regression in de Bruijn et al. (2005) showed that the TPB elements had the highest odds ratios after some distal factors such as ethnicity or school type. Heinen et al. (2011) and Muñoz et al. (2013) explored statistical differences in cycling indicators among commuter modes, and developed binary bicycle mode choice models including cycling latent variables based on the extended version of TPB (including habit). They applied this methodology in two completely different cycling environments.