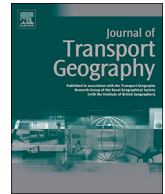




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Journal of Transport Geography

journal homepage: www.elsevier.com/locate/jtrangeo

Examining the determinants of utility bicycling using a socio-ecological framework: An exploratory study of the Tamale Metropolis in Northern Ghana

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ARTICLE INFO

Keywords:

Bicycle commuting
Travel behaviour
Sustainable
Transportation
Non-motorised transport
Ghana

ABSTRACT

This paper examines the determinants of utility bicycling through a cross-sectional study in Tamale, a metropolis with a long history of an embedded cycling culture in Ghana, West Africa. Using a socio-ecological framework, we model the extent to which individual-level characteristics, social environment factors and perceptions of physical environment factors at the neighbourhood and metropolitan scales influence choice of the bicycle as the main transport mode. An exploratory factor analysis distilled the indicators of the latent constructs of the socio-ecological framework into factors, which reflect physical environment challenges and opportunities perceived at the neighbourhood and metropolitan scales; influence of significant others; perceived status symbol of the bike; and perceived commuting benefits of bicycling. A binary logistic regression analysis of the determinants of utility cycling shows that while overall, bicycle ownership is an important determinant of cycling, between the genders, males are more likely to bicycle than females. Also, cyclists are more likely to be non-tertiary educated individuals. Whereas 'perceived neighbourhood-scale challenges' decrease the odds of cycling, 'perceived neighbourhood-scale opportunities', which reflect the availability of bicycle lanes, alternative roads and traffic control measures increase the likelihood of cycling among the study respondents. An interaction term between neighbourhood-scale physical environment opportunities and challenges, however, correlates negatively with cycling, suggesting that overall the metropolitan physical environment is not ideal for cycling. The study points to a huge potential for cycling in the metropolis and provides an empirical basis for interventions needed to remove barriers to bicycle commuting.

1. Introduction

Reducing motorised transport mode use and the attendant negative impacts on the environment and human health is crucial in the transitions towards sustainable urban futures. It is now recognized that promoting the adoption of active transport modes such as bicycling and walking constitutes one of the effective pathways towards creating environmentally friendly and healthier cities (Handy and King, 2011; Parkin et al., 2007).

Bicycle ridership is considered environmentally sustainable compared to motorised alternatives because of the low energy consumption and the absence of direct emission of pollutants such as green-house gases and noise (Gatersleben and Appleton, 2007). Moreover, the bicycle can offer several commuting benefits including affordability, reliability and speed, making it a suitable mode of transport for many urban and sub-urban trips (Bonham and Koth, 2010; Heinen et al.,

2010; Shaheen et al., 2010). Research has also demonstrated that bicycling on a regular basis could improve personal health by reducing sedentary lifestyles in the population (Haskell, 2004; Titze et al., 2008; Van Dyck et al., 2013).

Despite the many known benefits of utility bicycling, bicycle mode share in most cities across the globe is still considerably low (Gatersleben and Appleton, 2007; Heesch et al., 2014). In the context of African cities for example, the low adoption rate has been attributed to the negative image of cycling in the population, which many perceive as inferior alternative to the car; the lack of adequate infrastructure for non-motorised transportation; and the general failure of transport policy to incorporate cycling into the urban transport mix (Olvera et al., 2008; Acheampong, 2016; Brussel and Zuidgeest, 2012; Nkurunziza et al., 2012).

Notwithstanding the negative perceptions of cycling in the population and the general lack of interest in harnessing the potential of the

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bicycle, particularly in cities in developing countries, there are rare examples of bicycling culture to be found in these contexts. In Ghana, for example, the northern part of the country has long been known for its cycling culture, evidenced by the relatively high levels of bicycle ownership and use. It is estimated that nearly 11% of school trips in the Northern Region of Ghana are undertaken using the bicycle (Ghana Statistical Service, 2014). Moreover, while about 20% of the population across Ghana owned a bicycle, in the savannah regions (i.e. Northern, Upper East and Upper West regions), the level of ownership was found to be significantly higher at 63% according to the Ghana Living Standards Survey, Round 6, 2014¹ (Ghana Statistical Service, 2014). Although the forgoing statistics referred specifically to rural areas in the savannah regions and do not provide any information about bicycle use beyond ownership, they lend credence to the embedded cycling culture in these parts of the country. It therefore, makes interesting studying in this context, the underlying motivations for cycling among the population who do so and the barriers to cycling among those who do not.

The objective of this study, therefore, is to understand the determinants of utility bicycling in northern Ghana from the perspective of a socio-ecological model. To this end, we examine the influence of personal characteristics, perceived control and beliefs, attitudes and socio-environmental factors on adults' decision to bicycle for transportation in the Tamale metropolis, the biggest urban centre in the Northern part of Ghana. We aim, through understanding the behavioural influences of cycling in this unique case of cycling culture in Ghana, to provide empirical basis for cycling promotion interventions in the study area and possibly across other cities in the country.

The rest of the paper follows in four main sections. We first present the socio-ecological model for studying bicycling behaviour adopted in this study. Next, a brief discussion of the urban transportation situation in Ghana is presented to set the context for this study. The methodology adopted for this study is discussed focusing on the design of a questionnaire to measure the components of the socio-ecological model, sampling techniques, data collection and the method of analysis employed. In the fourth section, results of the analysis of the determinants of bicycling are presented followed by a discussion of the main findings of the study and their policy implications in the concluding section.

2. Socio-ecological models and bicycling behaviour

Traditionally, utility theory, which posits that people make their travel decisions by evaluating factors including out-of-pocket costs, travel time and personal convenience has underpinned analyses of travel behaviour (Ortúzar and Willumsen, 2011; Jain and Lyons, 2008; Acheampong and Silva, 2015). Increasingly, the role of more fundamental socio-psychological and ecological factors in interacting with personal attributes to influence travel choices has gained recognition, particularly in active transport (i.e. walking and bicycling) research (see e.g. Ghekiere et al., 2017; Sigurdardottir et al., 2013). This development is premised on the recognition that physical infrastructure-related investments as well as knowledge of beliefs, perceptions, attitudes and the influence of significant others (i.e. other persons who could have an influence on one's behaviour e.g. peers and parents) are crucial to successfully getting more people to adopt the bike as the main mode of transportation (Moudon et al., 2005; Acheampong, 2017; Sigurdardottir et al., 2013).

In a bid to better understand the behavioural influences of bicycling, researchers have deployed cognitive models such as the Theory of Planned Behaviour (TPB) (Ajzen, 1985, 1991). TPB-based research (see e.g. Sun et al., 2015; Bamberg et al., 2011; Quine et al., 1998; Chowdhury and Ceder, 2013) examines the motivations and barriers to behaviour as a function of individuals' attitude towards the behaviour

(e.g. bicycling), perceived control and subjective norm. Notwithstanding the usefulness of cognitive approaches such as TPB in understanding behaviour under volitional control, the emphasis on aggregating the factors influencing behaviour into the individual with little representation of other relevant external factors has come under criticism (see e.g. Handy and Xing, 2011; Alfonso, 2005).

Against the background of the weaknesses of the individually focused cognitive theories and models, current research has sought to integrate individual-level factors with external environmental factors to understand cycling behavior. Given that cycling is not only a means of travel but also a form of physical activity, it has been argued that the socio-ecological model (McLeroy et al., 1988) widely used in physical activity research in public health could provide a robust framework to conceptualize and understand cycling behavior (Sigurdardottir et al., 2013; Handy and Xing, 2011).

The social-ecology concept refers to the interrelationships between organisms (e.g. human beings) and their environments (i.e. social, physical and natural) (Sallis et al., 2008). The socio-ecological model posits that behavior is influenced by intrapersonal, interpersonal, institutional (i.e. formal and informal behavioural rules), community, and public policy factors (McLeroy et al., 1988). In other words, it recognizes that attributes of the individual as well as social, physical, natural and policy environments interact to influence behavior (McLeroy et al., 1988; Badland et al., 2013; Sallis et al., 2008; Elder et al., 2007). The socio-ecological model therefore integrates concepts and models from a broad range of disciplines.

At the level of the individual and within the context of cycling behaviour, a socio-ecological model considers intrapersonal factors including socio-demographics (e.g. age, gender, education, income; employment status), attitudes, perceived control and beliefs, and bicycle ownership in examining the determinants of cycling. Generally, age influences physical ability, hence previous research has concluded that cycling levels decline as people age (see e.g. Moudon et al., 2005; Dill and Voros, 2007). Previous studies have also shown that being female decreased the likelihood of cycling (Wardman et al., 2007; Parkin et al., 2008) or decreased intended adoption of utility cycling (Acheampong, 2017). The extant literature has arrived at mixed conclusions with respect to the influence of income on bicycle commute. While some studies have found a positive association between income and bicycle commuting (e.g. Shafizadeh and Niemeier, 1997), others have reported negative (e.g. Plaut, 2005; Parkin et al., 2008) or no effect of income on bicycle commuting (Stinson and Bhat, 2004).

In addition, attitudes, perceived control and self-efficacy, constructs originally captured in Ajzen's (1985, 1991) TPB as determinants of behaviour under volitional control have also been integrated into socio-ecological models (see e.g. Sigurdardottir et al., 2013). An individual's attitude reflects his or her expectations of outcomes of an activity and the personal values attached to them (Sutton et al., 2003) as well as specific opinions, intentions, affections, and beliefs (Handy and Xing, 2011; Heinen et al., 2011). It is hypothesised that where the expected outcomes of cycling to the individual are positive, they are more likely to adopt utilitarian cycling. Moreover, perceived control and self-efficacy—a person's evaluation of the possibility of performing certain behaviour and judgments of how well she/he can execute courses of action required to deal with prospective situations (Ajzen, 1991; Armitage and Conner, 2001)—determine whether they bicycle or not. Previous researchers have established that individuals who perceive more barriers to commuting by bicycle are less likely to cycle, and that in general, cyclists perceive more possibilities for cycling than non-cyclists (Gatersleben and Appleton, 2007). Nonetheless, in some other cases, negative perceptions of cycling outcomes have been associated with physical inability and poor health conditions (Handy and Xing, 2011).

Within the framework of the socio-ecological model, interpersonal and community factors on behaviour reflect in part, the influence of the wider social environment on an individual's behaviour (McLeroy et al.,

¹ Data is based on a sample population of 16,766 across Ghana interviewed as part of the Ghana Living Standards Survey, Round 6.

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