The influence of social-psychological factors on the intention to choose low-carbon travel modes in Tianjin, China

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ABSTRACT

This paper explores the relationships between travelers' intentions to use low carbon travel modes, a set of socio-psychological variables, and the influence of government supported low carbon travel policies. Specifically, a Comprehensive Intention Determination Model (CIDM) is used to study residents' low-carbon travel intentions, based on the theory of planned behavior (TPB) and value-belief-norm theory (VBN), and using structural equations modeling (SEM) applied to survey responses by 811 residents of the city of Tianjin, China. Low-carbon transport policies are shown to influence traveler intentions primarily through attitude, subjective and personal norms, awareness of consequence, and ascription of responsibility; and that combining positive social-psychological factors towards low-carbon awareness with effective low carbon transport policies can influence the residents' willingness to choose low-carbon travel modes to a moderate degree.

1. Introduction

Carbon emissions are one of the largest contributors to the global warming phenomenon that is now considered by many scientists to be threatening human well-being (Peters et al., 2013; Hu et al., 2015, 2016). The transportation sector produced nearly 25% of global CO_2 emissions in 2012. The annual growth rate of CO_2 emissions, including emissions from a growing transportation sector, is predicted to reach up to 1.7% in 2030 (International Energy Agency, 2010) with an annual growth rate rising to as high as 3.4% in 2030 within those developing countries that are transitioning their economy towards a more developed status (UN and Climate Changes, 2015). Hence policy makers within such developing nations should be looking to move their transportation systems along low-carbon, cleaner and more sustainable transport development pathways (Du et al., 2017).

Many travel demand management/mobility policies have been instituted around the world to encourage travelers to choose low-carbon travel modes (Litman, 2004; Fujii and Taniguchi, 2005), if to date with limited success when looked at from the perspective of mode shifts or other influences on aggregate travel volumes. Among the many challenges involved in moving towards low-carbon travel is the need to educate travelers about the opportunities for, and benefits of low-carbon transportation choices.[1] To date, while studies have focused on either people's psychological states or on their car use behavior, they have done so without explicitly considering a two-dimensional perspective that incorporates both internal (i.e. psychological) factors (Hafner et al., 2017) and external (i.e. transport policy impacted) factors (Marsden and Docherty, 2013; Marsden et al., 2014). However, a preference for

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adopting low-carbon travel choices can be expected to be closely associated with a person's internal motivation towards environmentally sound options: preferences that may be either enhanced or dampened by externally imposed travel policies (Mattauch et al., 2006; Steg and Vlek, 2009; Pathak and Shukla, 2016). Hence, this paper describes a research project that focuses on understanding residents' current perceptions about low-carbon travel, and in particular on how both psychological factors and external policy driven factors both directly and indirectly interact to influence travelers' perceptions about travel alternatives.

In considering such a strategy, it is widely recognized that behavioral intention is a key to actual behavior (Ajzen, 1991). To this end, the theories of planned behavior (TPB) and value-belief-norm theory (VBN) have been used for evaluating behavioral, including traveler intentions towards low-carbon travel options (Garling et al., 2003; Donald et al., 2014; Lind et al., 2015). TPB and VBN have both been validated in the field of pro-environmental behavior,[2] such as energy consumption behavior (Steg and Gifford, 2005; Botetzagias et al., 2015), and travel behavior (Mancha and Yoder, 2015; Munshi, 2016), including private car use (Garling et al., 2003; Liobikienė et al., 2016). These previous studies focus on extending TPB or VBN models by introducing variables such as descriptive norms (Cristea et al., 2013), perceived environmental concerns (Donald et al., 2014; Hyungsook, 2016), perceived moral obligation (Chen et al., 2014), green trust (Choi et al., 2015), and habit (Donald et al., 2014; Lo et al., 2016). However, neither TPB nor VBN modeling alone has been able to explain pro-environmental behavioral intention to a satisfactory level (Abrahamse and Steg, 2011). This led Lane and Potter (2007) to consider a combination of TPB and VBN modeling approaches as a means of improving the explanatory power of such intentions modeling. Building on this idea, we study the impact of social-psychological factors on low carbon travel intention based on an integration of TPB and VBN. In doing so, this paper presents the first version of a Comprehensive Intention Determination Model (CIDM) based on this integration of TPB and VBN, to determine how low carbon travel intention is affected both directly and indirectly by a number of low-carbon awareness and policy variables.

Specific features of the study include examining individual behavioral intention from three distinctly different directions: (1) from the perspective of psychological factors as determined from TPB and VBN analysis, (2) from the concept of low carbon awareness, and (3) from the perspective of government policy. The paper discusses representative low-carbon transport policies that have been taken in China, such as restricting certain plate numbers from driving on certain days,[3] restricting automobile purchases,[4] and the use of lottery and auction policies.[5] Policies that restrict automobile purchases and/or driving activity have been introduced in China in recent years, and their acceptance by the traveling public is currently a policy issue of some interest. We investigate whether such policies either directly or indirectly make any difference to travelers' intention to adopt low-carbon travel options. In addition, although there is a low-carbon awareness-behavior gap, low-carbon awareness has been examined as a moderator which should not be neglected in explaining behavior (Bai and Liu, 2013).

The remainder of the paper is organized as follows. The theoretical background and framework, including relationships between the variables, are stated in Section 2. In And 34 the research method is explained, based around a survey of residents' attitudes towards low-carbon travel modes. This is followed by a results section in which the mechanisms influencing travel mode intentions are described in detail. In the final section, a discussion of the empirically-based modeling results is provided and suggestions are formulated for low-carbon travel intention targeting.

2. Theoretical framework

The theory of planned behavior and value-belief-norms theory are representative theories in the study of pro-environmental behavior. The following paragraphs summarize recent literature on each approach in the context of behavioral intentions towards environmentally sensitive choices. The theoretical framework of this paper is based on this discussion of relationships among influential variables.

2.1. The Theory of Planned Behavior (TPB)

TPB offers a model of the psychological determinants of an individual's behavior (Ajzen, 1991). According to TPB, behavioral intention is explained by three items. First is attitude towards the behavior (ATT), which is either positive or pessimistic. Second is subjective norms (SN), representing a kind of pressure from society to engage or not engage in a behavior. Third is perceived behavioral control (PBC), which refers to a person's perceptions of their ability to perform a given behavior. TPB predicts that, in general, a more positive attitude, stronger subjective norms, and greater perceived behavioral control will promote an individual's intention to perform more environmentally sound behavior (Kaiser and Scheuthle, 2003; Steg and Vlek, 2009).

2.2. Value-Belief-Norm theory (VBN)

VBN was first presented by Stern et al. (1999), combining aspects of Value Theory (Schwartz, 1977), New Ecological Paradigm (NEP) (Dunlap and Van Liere, 1978) and Norm-Activity Theory (NAT) (Berkowitz et al., 1964). A causal chain was presented by Stern

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[2] Pro-environmental behavior refers to behavior that harms the environment as little as possible, or even benefits the environment.

[3] Traffic restrictions are based on even- and odd-numbered license plates.

[4] Automobile purchase restriction policy was taken to curb pollution and traffic using either auctions or lotteries.

[5] Two main measures have emerged: lotteries in which licenses are handed out free (or for a small fee) to random winners and auctions in which the highest bidders get the license. There is a growing list of cities that use these measures. Beijing, Guiyang and Hangzhou use lotteries, while Shanghai and Tianjin use auctions. Guangzhou split the difference and issues half of available licenses through an auction and the other half through a lottery.