Journal of Transport & Health 3 (2016) 336–345

Contents lists available at ScienceDirect

Journal of Transport & Health

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

A dynamic framework on travel mode choice focusing on utilitarian walking based on the integration of current knowledge

Yong Yang *

School of Public Health University of Memphis Memphis, TN 38152, United States

ARTICLE INFO

Article history:
Received 2 August 2015
Received in revised form
28 February 2016
Accepted 2 March 2016
Available online 17 March 2016

Keywords:
Utilitarian walking
Travel mode choice
Dynamic framework
Built environment
Feedback

ABSTRACT

Recently, research on utilitarian walking has gained momentum due to its benefits on both health and the environment. However, our overall understanding of how built and social environments affect travel mode choice (walking or not) is still limited, and most existing frameworks on travel mode choice lack dynamic processes. After a review of several mainstream theories and a number of frameworks, we propose an integrated framework. The basic constructs in the travel mode choice function are utilities, constraints, attitudes, and habits. With a hierarchical structure and heuristic rules, the travel mode choice function is modified by individual characteristics and travel characteristics. The framework explicitly presents several dynamic processes, including the perception process on the environment, attitude formation process, habit formation process, interactions among an individual's own behaviors, interactions among travelers, feedback from travel to the built and social environments, and feedback from other behaviors to the built and social environments. For utilitarian walking, the framework may contribute to the study design, data collection, adoption of new research methods, and provide indications for policy interventions.

1. Introduction

Recently, numerous empirical studies have been published on utilitarian walking as a travel mode due to benefits of walking on physical and mental health, as well as its potential to decrease air pollution and traffic congestion and to promote sustainable urban development and social cohesion in neighborhoods (Lee and Buchner, 2008; Pucher and Buehler, 2010; Pucher and Dijkstra, 2003). Evidence shows that utilitarian walking is associated with individual characteristics, such as age, sex, socioeconomic status, race/ethnicity, auto ownership, and psychological properties including attitude and habits (Joh et al., 2012; Cerin et al., 2009), and built and social environmental characteristics, such as the land-use density, land-use mix, street connectivity, street design, aesthetics, traffic safety, level of violence, social support, social network, social cohesion, and social norm (Cao et al., 2006; Transportation Research Board, 2005; Mendes et al., 2009; Vojnovic, 2006). Simultaneously, a number of conceptual frameworks have been proposed that focus on physical activity in general (Transportation Research Board, 2005; Sallis et al., 2006), active travel including walking and bicycling (Krizek et al., 2009; Ogilvie et al., 2011), or more specifically on children's travel to school (Panter et al., 2008; Pont et al., 2011). Most of these frameworks are extensions of theories, including utility theory (Mcfadden, 1974; Ben-Akiv and Lerman, 1985), the theory of planned behavior (TPB) (Ajzen, 1991; Rhodes and Dickau, 2012), or the social-ecological model (Transportation Research Board, 2005; Handy, 2005). Substantial progress has been made towards the understanding of how a travel mode is chosen (by walking or not), especially the incorporation of psychological properties and multiple factors at multiple levels.

Utility theory is one of the core theories in the transportation field, stating that people make rational decisions to maximize their interests (Mcfadden, 1974; Ben-Akiv and Lerman, 1985; Sen, 2008). The basic rationale of traditional travel mode choice models is that a person will select a travel mode that could maximize her/his benefits and minimize her/his costs. Although utility theory has been widely and consistently applied to travel behavior with substantial improvements over the past several decades (Ramos et al., 2014), utilitarian walking is not the focus. The utilities beyond travel cost and time may be more important to utilitarian walking compared with other travel modes (Transportation Research Board, 2005; Handy, 2005). For example, for a walking trip, positive utilities may include the enjoyment of walking itself, the enjoyment of the interaction with the environment and other persons, and the satisfaction of the potential

* Tel.: +1 901 678 5018.
E-mail address: Yyang15@memphis.edu

http://dx.doi.org/10.1016/j.jth.2016.03.002
2214-1405/

benefit to physical health. In addition, negative utilities may include physical fatigue, as well as exposure to heavy traffic, polluted air, unsafe environments, and severe weather. In the field of physical activity, the TPB may be the most widely applied theory (Sutton, 2002; Lee and Shepley, 2012; Guell et al., 2012; Darker et al., 2009; Rhodes et al., 2006). According to TPB, attitude, subjective norms, and perceived behavioral control jointly determine the formation of the intention that is the direct determinant of behavior. At the same time, perceived behavioral control could influence behavior directly.

For frameworks related to walking, substantial progress has been the incorporation of psychological properties. Both utility theory and the TPB have been criticized for their assumption that people always behave rationally. In reality, a person may choose a satisfactory travel mode instead of the optimal one (Chorus and Dellaert, 2012). A person's rationality is bounded by her/his cognitive limitations, the available information, limited amount of time available to make decisions, the cost of research and learning, and inaccurate memory (Kahneman et al., 1997; Rebecca et al., 1999; Barff et al., 1982; Aarts et al., 1997). For example, a driver may select a different route to avoid heavy traffic if the traffic information could be accessed in real time or may even decide to choose an alternative travel mode. Some psychological properties are largely unexplored, for example, how people shape their perceptions to reduce dissonance (McFadden, 2001). Some psychological properties are challenging to capture, for example, habit, either by utility theory or the TPB (de Bruijn et al., 2009; Verplanken et al., 1998). People are not constantly conscious of their behavior. When a behavior is repeatedly performed, it may become habitual (Aarts et al., 1998; Bamberg et al., 2003). This is especially true for daily travel that is executed on a repetitive basis and that therefore may become routine or habitual. Evidence (de Bruijn et al., 2009; Verplanken et al., 1997; de Bruijn and Gardner, 2011; Murtagh et al., 2012) has shown that habit strongly influences travel mode choice. An attitude has a weaker influence on the corresponding behavior when the corresponding habit is strong and has a stronger influence when the habit is weaker (Garvill et al., 2003; Triandis, 1977; Verplanken et al., 1994).

The issue of psychological properties has been acknowledged from the origin of utility theory, and continuous efforts have been initiated to incorporate psychological properties especially attitude, preference, and perception (McFadden, 2001; Ben-Akiva et al., 1999; Fried et al., 1977). For example, experienced utility was distinguished from decision utility to capture better the properties that are related to travel satisfaction (Kahneman et al., 1997). Recent empirical research found travel satisfaction was influenced by travel mode and personal and environmental factors (De Vos et al., 2015; Ettema and Smajic, 2015). Active travel such as walking, is likely to yield high travel satisfaction due to its benefits of autonomy, environmental mastery, social interaction, and involved physical activity (Ettema and Smajic, 2015), whereas private vehicle use is likely to be associated with symbolic and affective benefits (e.g., the car may be taken as symbol of status and success) (Steg, 2007).

Additional substantial progress has been to incorporate the effects of multiple factors at multiple levels and the interrelations among these factors (Krizek et al., 2009; Handy, 2005; Sallis et al., 2008). The social-ecological model (Transportation Research Board, 2005; Handy, 2005), which has gained increasing attention over the past decade, is considered to be an improvement over the social cognitive theory (Bandura, 1986; Glanz and Bishop, 2010; Plotnikoff et al., 2013) because the latter is criticized as being focused on the social environment and does not represent the physical environment well (Handy, 2005). The social-ecological models consider both the social and physical environments and are taken to be an essential guide to the design of effective multilevel interventions to increase physical activity, including utilitarian walking (Sallis et al., 2008).

However, one major problem for most frameworks is the lack of dynamic processes by which the behavior (specifically, utilitarian walking), attitude and habit, and environment are directly or indirectly shaped. The dynamic processes are ubiquitous and continuously adapt to reduce the imbalance between current or expected needs and available opportunities (Fried et al., 1977). As criticized by Barff et al. (1982, page 378), "…Most models are cross-sectional in nature, trying to explain today's behavior by today's attitudes. However, today's attitudes are of limited help in learning how attitudes may change; we must know when and how the attitudes were originally formed". In addition, a habit may be broken by changes including both major life events and daily exposures (Guell et al., 2012). Major life events, such as moving one's residence, changing jobs, or getting married, may break habits because of the abrupt contextual change (Verplanken et al., 2008; Scheiner, 2007; Doring et al., 2014). On the other hand, people are constantly exposed to smaller changes every day from the environment and other people, and such daily exposure may cumulatively influence the travel mode. We need to account for the dynamic relationships among persons (e.g., the walking by one individual affects other's behaviors), between persons and their built and social environments (e.g., the environmental changes in response to person's walking and vice versa), and among environmental characteristics (e.g., the change of residence distribution may initiate a corresponding change in the transport network) (Cerin et al., 2009).

Another problem is that most frameworks, especially those being based on social-ecological models, are not operation-oriented. Most of them simply demarcate boundaries between different levels and list a number of characteristics within each level but seldom provide the interactions among these features; therefore, they fail to indicate how an interaction may lead to behavioral and environmental changes (Ogilvie et al., 2011).

Our understanding of how an empirical intervention may increase utilitarian walking (and overall physical activity) is limited (Ogilvie et al., 2007), and research on health behaviors (Glanz and Bishop, 2010) has shown that interventions based on theoretical frameworks or theoretical constructs are more effective than are those without them. Indeed, we need frameworks at both the conceptual and operational levels to provide indications for both theoretical research and policy interventions (Ogilvie et al., 2011).

Theories may be complementary to each other. As reviewed (Handy, 2005), the utility theory is operation-oriented, that is, it provides an operational mechanism by which the properties affect the travel mode choice, but it does not suggest how to delineate physical activity behavior as discrete mode choices or what properties might be relevant to those choices. On the contrary, the TPB and social-ecological model define specific properties influencing travel behavior and may provide causal mechanisms regarding how these properties work together. However, most mechanisms are presented in a qualitative term; thus, it is not clear to what extent and how fast one property could influence another property. With this consideration, we believe that the combination of various theories and frameworks, together with the accumulated evidence from empirical research, provide a knowledge foundation on which a more comprehensive framework could be based.

This research aims to create a dynamic framework for travel mode choice focusing on utilitarian walking. First, we review the current knowledge on travel mode choices, focus on a number of published frameworks. Next, we propose an integrated framework and describe its key features. Finally, we discuss the framework's values, utilities, limitations, and challenges.