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# From attitude to satisfaction: introducing the travel mode choice cycle

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## ABSTRACT

Many studies analysing the relationship between attitudes and travel behaviour have found that travel attitudes have an important impact on travel mode choice. More recently, studies focusing on how people experience travel have shown that travel satisfaction is influenced by the chosen travel mode. The desire and intention of using a travel mode – which can be considered as important predictors of mode choice – have, however, received limited attention. Furthermore, existing studies mostly have a narrow scope and lack integration of the above constructs. In this paper, we introduce the travel mode choice cycle (TMCC), a comprehensive model aiming to link attitude, desire, intention, behaviour, and satisfaction by integrating prominent social-psychological attitude theories such as the theory of planned behaviour, the model of goal-directed behaviour, and the theory of cognitive dissonance. We argue that the constructs of the TMCC are strongly interrelated such that they can affect each other in direct and indirect ways. The proposed cycle provides valuable insights for policymakers to stimulate the use of desired travel modes, such as public transport and active travel. We end this paper by providing suggestions for future studies to simultaneously investigate the relationships specified by the TMCC.

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## KEYWORDS

Travel behaviour; travel mode choice; attitude; desire; intention; satisfaction

## 1. Introduction

Historically, the primary goal of travel behaviour research has been to forecast how people choose whether, where, when, and how to travel (McNally, 2007). Only a limited number of factors (such as travel time and cost) were posited to explain these choices. Partly due to the influences of attitude theories in social psychology (Albarracín & Johnson, 2019; Eagly & Chaiken, 1993), attitude was introduced early in travel behaviour research as an additional explanatory construct (Gärling, Gillholm, & Gärling, 1998; Golob, Horowitz, & Wachs, 1979). It was expected that attitudes would improve the predictive

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validity of disaggregate choice models (Ben-Akiva et al., 1999). Subsequently, many empirical studies – dating back to the 1970s – have focused on the effects of travel attitudes on travel behaviour, and travel mode choice in particular. They have mostly found that attitudes are strong predictors of the chosen travel mode, even stronger than, for instance, the built environment and residential location (e.g. Bagley & Mokhtarian, 2002; Handy, Cao, & Mokhtarian, 2005; Kitamura, Mokhtarian, & Laidet, 1997). Some studies have also found significant effects of travel behaviour on travel attitudes (e.g. Dobson, Dunbar, Smith, Reibstein, & Lovelock, 1978; Kroesen, Handy, & Chorus, 2017; Tardiff, 1977).

More recently, studies have focused on how people perceive their trips and how satisfied they are with them (De Vos & Witlox, 2017; Ettema, Gärling, Olsson, & Friman, 2010). The results of several of these studies show that the chosen travel mode has an important influence on satisfaction with travel (e.g. De Vos, Mokhtarian, Schwanen, Van Acker, & Witlox, 2016; Morris & Guerra, 2015b; St-Louis, Manaugh, van Lierop, & El-Geneidy, 2014). Some studies have also demonstrated effects from mode-specific attitudes on satisfaction with trips using these modes, claiming that it is not only the travel mode itself that affects travel satisfaction, but whether or not attitudes are positive towards the chosen mode (e.g. De Vos, 2018; Ye & Titheridge, 2017). At the same time, being satisfied with trips using a given travel mode may positively affect attitudes towards and the desire to use that mode, and consequently the likelihood of choosing it in the future (De Vos, Schwanen, Van Acker, & Witlox, 2019a).

According to social-psychological attitude theories, intention is generally regarded as an important predictor of behaviour that mediates the influence of attitude (e.g. Ajzen, 1991; Triandis, 1977). Although only a limited number of studies have investigated intended travel mode use, the results that exist indicate that the intention to use a certain mode has a strong effect on choosing the mode (e.g. Bamberg, Ajzen, & Schmidt, 2003a, 2003b), and that the intention is affected by the attitude towards the mode (e.g. Chen & Chao, 2011; Eriksson & Forward, 2011). Studies of desire have mainly focused on desired travel amounts (Mokhtarian & Salomon, 2001; Redmond & Mokhtarian, 2001), although some studies analysed the desired use of a certain travel mode (e.g. public transport (Carrus, Passafaro, & Bonnes, 2008; De Vos, Waygood, & Letarte, 2020a)).

In sum, travel behaviour studies have briefly examined the desired and intended travel mode use, while considerable attention has been paid to travel attitudes, travel mode choice, and recently also travel satisfaction. Although some of these studies analysed links between two or three of these constructs, a study focusing on the multiple links between all five constructs is non-existent, despite the valuable information on travel behaviour and travel mode choice that such an analysis could provide. In this conceptual paper, we examine how satisfaction, attitude, desire, and intention are related to travel mode choice. We analyse existing social-psychological attitude theories and, based on these, propose a conceptual framework referred to as the “travel mode choice cycle” (henceforth TMCC). The limited scope and integration of these theories in previous studies calls for a more general, and likely more valid, model explaining travel mode choice. We claim that the TMCC creates new insights into travel behaviour research as it can help explain travel mode choice and ways to stimulate the use of desired travel modes (i.e. active travel and public transport).

The remainder of this paper is structured as follows. Section 2 describes how attitude, desire, intention, behaviour, and satisfaction have been analysed in existing travel behaviour studies. In Section 3, an overview is given of the social-psychological attitude theories that have been used as theoretical frameworks in existing studies and their insights into the determinants of travel mode choice. Section 4 introduces the TMCC suggesting how attitude, desire, intention, behaviour, and satisfaction are – in terms of travel mode – inter-related. Section 5 highlights the importance of the TMCC in explaining travel mode choice and attempts to change people's mode choices, while we end this section with suggestions for future studies to examine the cycle.

## 2. Examining attitude, desire, intention, behaviour, and satisfaction in travel behaviour research

In this section, short descriptions are given of attitude, desire, intention, behaviour, and satisfaction in a travel-related context, and how these constructs have been measured in previous studies. These constructs have rarely been analysed in isolation, and the possible links between them will be discussed in Sections 3 and 4.

Travel mode *attitude* refers to the degree of favourable or unfavourable evaluation or appraisal of a certain travel mode.<sup>1</sup> Many studies have incorporated attitude measures in surveys of the liking of different travel modes, mostly in the form of agreement ratings of statements (e.g. Bagley & Mokhtarian, 2002; Handy et al., 2005; Kitamura et al., 1997), but occasionally also by asking to what extent respondents link positive aspects (e.g. relaxing, safe, fun) with the use of certain travel modes (e.g. Kroesen et al., 2017). As a special type of affective belief, preferences mainly relate to a greater liking for one alternative over another or others.<sup>2</sup> Studies comparing attitudes towards different modes suggest that people mostly prefer active travel modes over motorised modes (e.g. De Vos, 2018).

The *desire* to use a travel mode has not been analysed frequently. Most studies examining desire in a travel-related context have focused on the desire to travel itself and analysed people's desired commute duration (Humagain & Singleton, 2020a; Redmond & Mokhtarian, 2001; Ye, De Vos, & Ma, 2020), their desire to reduce, maintain, or increase current levels of travel (Choo, Collantes, & Mokhtarian, 2005; Ory & Mokhtarian, 2009), or whether or not people desire to travel using the "teleportation test" (Humagain & Singleton, 2020b; Mokhtarian & Salomon, 2001).<sup>3</sup> Some studies also focused on older adults' (unmet) travel needs and their desire to remain mobile and reach desired out-of-home activities (e.g. Luiu, Tight, & Burrow, 2017; Nordbakke & Schwanen, 2015). We are only aware of three studies investigating the desire to use a certain travel mode; one obtaining ratings of the desired public transport use frequency (on a 5-point scale from *never* to *mostly*) (De Vos et al., 2020a), one obtaining agreement ratings of statements about the desire to use public transport instead of the car (Carrus et al., 2008), and one measuring the effect of (perceived) mode use on the desire to use other modes (Choo et al., 2005).

Studies analysing the *intention*<sup>4</sup> to use a certain travel mode – i.e. the planned/expected<sup>5</sup> use of a mode – are fragmented, partly since intention often has been analysed in studies applying so-called stated preference models (e.g. to understand potential use of new modes or services). Other studies have often used agreement ratings of statements to measure the extent to which respondents intend to reduce car use (Taniguchi & Fujii,

2007), use alternatives for the car (Anable, 2005), switch to public transport (Carrus et al., 2008; Chen & Chao, 2011), or use various travel modes for future trips (Bamberg et al., 2003a; Eriksson & Forward, 2011). Van, Choocharukul, and Fujii (2014) asked university students what their intended commute mode would be when getting a job, while De Vos et al. (2020a) asked university students to indicate their intended frequency of public transport use in later life stages (on a 5-point scale from *never* to *mostly*).

*Behaviour* in a travel mode choice context has been measured in a variety of ways: as the rated frequency of the use of different travel modes (mostly using ordinal scales, e.g. from *never* to *always* or from *less than once a year* to *(almost) every day*); reports of distance covered or number of trips performed by different travel modes within a certain time frame (e.g. the past day or week); the self-reported mode choice of a typical or most recent trip for a certain purpose; or modal splits (i.e. observed fractions of trips per travel mode) (see, e.g. Bamberg et al., 2003a; De Vos, Ettema, & Witlox, 2018; Handy et al., 2005; Kitamura et al., 1997; Kroesen et al., 2017; Molin, Mokhtarian, & Kroesen, 2016). Studies have shown that suburban residents travel more by car than urban residents do, but also that attitudes play an important role in which travel mode is chosen (e.g. Ewing & Cervero, 2010).

Travel *satisfaction* refers to emotions experienced during trips as well as a cognitive evaluation of the whole journey or stages of the journey after its completion.<sup>6</sup> In the past decade, many studies have investigated satisfaction with travel, often using the Satisfaction with Travel Scale (Ettema et al., 2011). Although this scale has proven to be a reliable measure of travel satisfaction (De Vos, Schwanen, Van Acker, & Witlox, 2015; Friman, Fujii, Ettema, Gärling, & Olsson, 2013; Singleton, 2019a), some studies have instead used agreement ratings of statements, inspired by the Satisfaction with Life Scale (Diener, Emmons, Larsen, & Griffen, 1985), to measure satisfaction with daily travel (Bergstad et al., 2011), and satisfaction with commuting and leisure travel (De Vos, Ettema, & Witlox, 2019b). Studies indicate that people are in general relatively satisfied with their travel, especially with trips using active modes, having short durations, and for non-commute purposes (e.g. De Vos, 2019; Olsson, Gärling, Ettema, Friman, & Fujii, 2013).

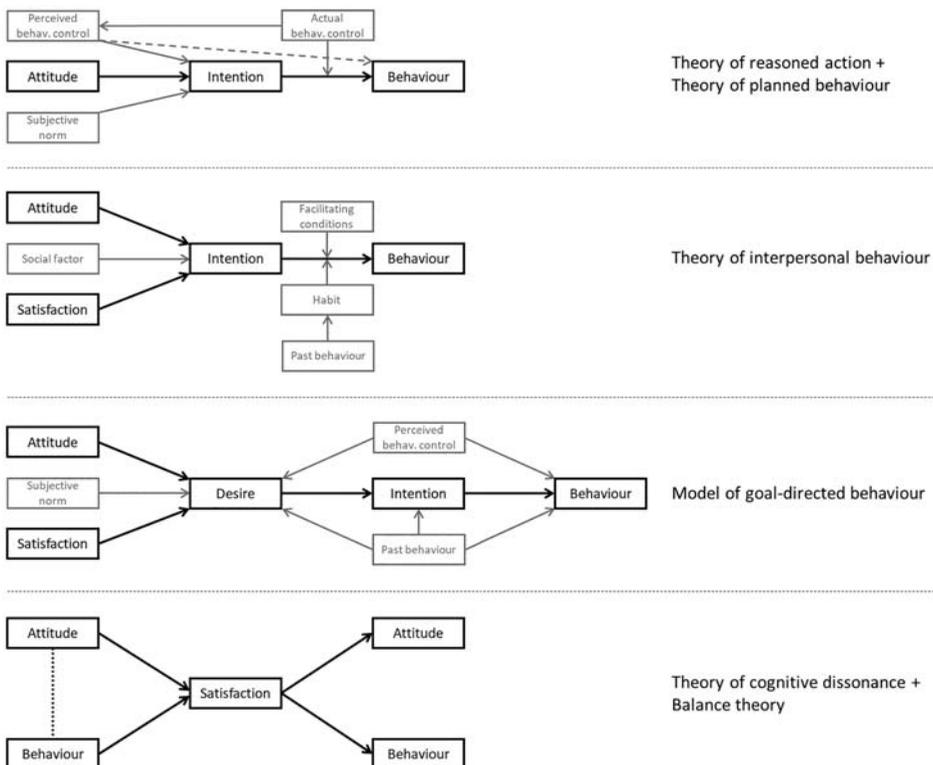
It should be noted that the five constructs discussed above may also be influenced by people's personalities and lifestyles, which are more inherent to people and more resistant to change than the five constructs.<sup>7</sup> Although travel behaviour studies incorporating lifestyle and personality are limited, some have found that lifestyles can affect travel behaviour and attitudes, while others have shown that certain personality traits can influence travel mode choice, travel satisfaction, and travel attitudes (Abou-Zeid & Ben-Akiva, 2011; Johansson, Heldt, & Johansson, 2006; Ory & Mokhtarian, 2005, 2009; Van Acker, Mokhtarian, & Witlox, 2011). We acknowledge that additional constructs related to attitude, desire, intention, behaviour, and satisfaction exist, which would be more commonly recognised in theories originating from other social sciences (e.g. sociology). In this paper, however, we will focus on the five constructs most used in social-psychological attitude theories.

### 3. Psychological theories in travel behaviour research

Mainly in the past two decades, there has been an increasing recognition that subjective elements such as perceptions, attitudes, and beliefs influence travel behaviour choices. As

a result, many travel behaviour researchers have turned to social-psychological attitude theories to guide and explain their findings (Bohte, Maat, & van Wee, 2009; Mokhtarian, Salomon, & Singer, 2015; Singleton, 2013). In this section, we describe the theories of reasoned action and planned behaviour, the theory of interpersonal behaviour, the model of goal-directed behaviour, the theory of cognitive dissonance, and the balance theory, which all are theories that may be or have proven to be applicable to the travel mode choice. These theories make different propositions of how attitude, desire, intention, behaviour, and satisfaction are related. Figure 1 gives an overview of these theories.

The *theory of reasoned action* (Fishbein & Ajzen, 1975) and its extension the *theory of planned behaviour* (Ajzen, 1991) propose that an intention to perform a behaviour is the primary driver of the actual behaviour, while intention is directly influenced by attitude towards the behaviour, subjective norm (the perceived social pressure to perform or not to perform a behaviour), and (according to the theory of planned behaviour) perceived behavioural control (the perceived ease of performing a behaviour).<sup>8</sup> The perceived behavioural control is affected by the actual behavioural control (i.e. the actual ease of performing a behaviour (affected by available opportunities)), while the performance of a behaviour is affected by both actual and perceived behavioural control and additionally depends on the extent to which the perceived behavioural control is



**Figure 1.** Overview of social-psychological attitude theories applied in travel behaviour research (black: (effects between) attitude, desire, intention, behaviour and satisfaction; grey: (effects between/originating from) other constructs; behav. = behavioural).

aligned with the actual control of the behaviour. Many travel behaviour studies analysing the effects of attitudes on travel mode choice refer to these theories in explaining their findings. Some directly inspired by the theory of planned behaviour (e.g. Anable, 2005; Bamberg et al., 2003a; Chen & Chao, 2011; Eriksson & Forward, 2011) have mostly confirmed the theoretically posited influences of attitudes, subjective norm, and perceived behavioural control on intentions, and of intentions on behaviour.

The *theory of interpersonal behaviour* (Triandis, 1977) is closely related to the theories of reasoned action and planned behaviour. However, besides attitudes and social factors (including norms, roles and self-concept),<sup>9</sup> the theory also posits that emotions and satisfaction influence intention, and that habits (resulting from past behaviour) mediate the effect of intention on behaviour. Facilitating conditions, i.e. opportunities and constraints enabling or hindering the performance of a behaviour (comparable to actual behavioural control in the theory of planned behaviour), can distort the effect of intention on behaviour. The theory of interpersonal behaviour is not widely used in travel behaviour studies. An exception is Domarchi, Tudela, and González (2008), who used it as a framework and found the expected effects of attitudes, habits, and affective (emotional) appraisal on car and public transport use. Also, Galdames, Tudela, and Carrasco (2011) draw on this theory for explaining the effects of attitudes and satisfaction (together with social factors) on intended travel mode use.

The *model of goal-directed behaviour* (Perugini & Bagozzi, 2001) is similar to the theory of interpersonal behaviour, but it includes desire as a mediator between attitude and intention. According to this model, attitude, satisfaction (defined as anticipated emotions), subjective norm, and perceived behavioural control affect desire, while perceived behavioural control can also directly influence behaviour; and desire, intention, and behaviour are affected by past behaviour. Only two studies have used this model to explain travel mode choice. Both Carrus et al. (2008) and De Vos et al. (2020a) found that the desire to use public transport is positively affected by attitude towards as well as (anticipated) satisfaction with public transport, while desired public transport use positively influences (intended) public transport use.

The *theory of cognitive dissonance* (Festinger, 1957) and the *balance theory* (Heider, 1958) indicate that an inconsistency between attitude and behaviour results in negative feelings of discomfort. In order to reduce these feelings, people strive to restore the cognitive balance between attitude and behaviour by either changing the behaviour or the attitude. In contrast to the theories described above,<sup>10</sup> the cognitive dissonance and balance theories posit other mechanisms for how attitudes may change. As a result, these theories are often used to explain changes in attitudes. Some travel behaviour studies have used the theory of cognitive dissonance to explain observed changes in travel attitudes (see, De Vos & Singleton, 2020, for an overview). For instance, Kroesen et al. (2017) found that if people experience a dissonance between mode-specific attitudes and mode choice, they are more likely to adjust their attitudes than their behaviour. Likewise, Lin, Wang, and Guan (2017) made frequent references to the cognitive dissonance theory in explaining effects of the built environment on travel attitudes of recently relocated residents.

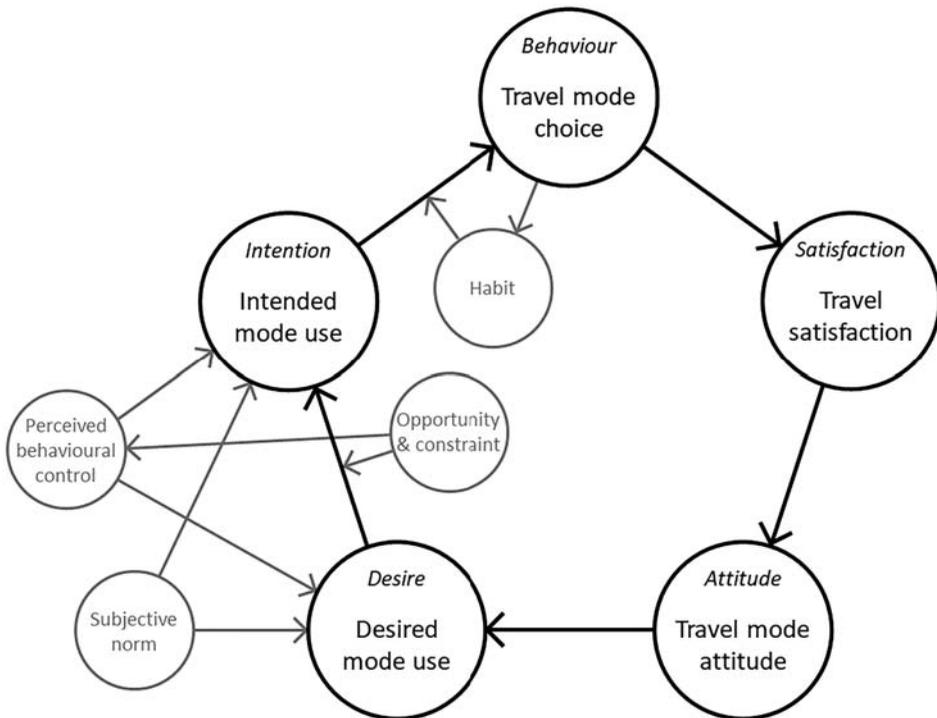
Although most theories presented in Figure 1 seem unidirectional with behaviour as the major outcome, the theory of cognitive dissonance and balance theory suggest a cyclical process in which satisfaction is affected by the interaction between attitudes

and behaviour, and in turn can impact future attitudes and behaviour. Also, the theory of interpersonal behaviour and the model of goal-directed behaviour can be considered as cyclical since they indicate that past behaviour can influence behaviour, directly or indirectly (through desire or intention). By considering behaviour as not just an outcome of other constructs, but also as an important predictor, a cyclical process emerges. In the following section, we introduce such a process – inspired by the above theories – including attitude, desire, intention, behaviour, and satisfaction.

#### 4. The travel mode choice cycle

The social-psychological attitude theories presented in Section 3 are similar in their proposed relations between attitude, intention, desire, behaviour, and satisfaction. In this section, we present an integrated conceptual model referred to as the “travel mode choice cycle” (TMCC) which connects these five constructs with travel mode choice, and also indicates how perceived behavioural control, subjective norm, habit, and opportunity/constraint relate to these constructs (see Figure 2).

The five *direct effects* between the main constructs included in the cycle have been empirically analysed. To begin with, mode-specific attitude can affect the desire to use that mode. Carrus et al. (2008) and De Vos et al. (2020a) found such an effect from public transport attitudes to the desire to use public transport. These two studies also found that the desire to use public transport positively affects the intention to travel



**Figure 2.** The travel mode choice cycle, linking attitude, desire, intention, behaviour, and satisfaction (other constructs influencing the primary constructs are shown in grey).

by public transport. The effect of the intention to use a certain mode on mode choice is mostly examined by studies analysing the theory of planned behaviour (e.g. Bamberg et al., 2003a, 2003b). These studies have found strong positive effects of mode choice intention on the actual choice of that mode. In the past decade, evidence has further accumulated that choice of travel mode influences travel satisfaction; active travel mostly results in high levels of trip satisfaction, while the use of motorised modes (especially the bus) results in relatively low satisfaction levels (e.g. De Vos et al., 2016; Morris & Guerra, 2015b; Singleton, 2019b; St-Louis et al., 2014). Finally, it is possible, that travel satisfaction affects mode-specific attitudes, since positively experienced trips with a certain mode may positively influence a person's stance towards that mode. However, only one study analysed this potential effect, indicating that positively experienced walking and cycling trips result in more favourable attitudes towards these modes (De Vos et al., 2019a).

Besides these direct effects as shown in Figure 2, multiple *indirect effects* have empirical support. Several studies since the 1990s have demonstrated strong effects of travel attitude on intended mode use (e.g. Eriksson & Forward, 2011; Van et al., 2014), and actual mode use (e.g. Bagley & Mokhtarian, 2002; Heinen, Maat, & van Wee, 2011; Kitamura et al., 1997), not taking into account possible mediating effects of desire (and intention). Although most studies have focussed on the effects of attitudes on behaviour, some studies have also found opposite effects from travel mode use on attitudes towards these modes (De Vos, Cheng, & Witlox, 2020b; Dobson et al., 1978; Golob et al., 1979; Kroesen et al., 2017; Tardiff, 1977). Mode choice has also been used as an explanatory variable for other constructs. Bamberg, Rölle, and Weber (2003b), for instance, found that car use frequency has significant negative effects on the intention to change from car to public transport and attitudes towards public transport, while Carrus et al. (2008) found that the frequency of public transport use (in the last two weeks) positively affects the desire and intention to use public transport instead of the car. Studies of travel satisfaction have found that besides the chosen travel mode itself, mode-specific attitudes also impact satisfaction. A positive attitude towards a certain travel mode positively affects satisfaction with a journey using that mode (De Vos, 2018; St-Louis et al., 2014; Ye & Titheridge, 2017). Travel satisfaction may also impact travel behaviour since choices are often based on how previous choice outcomes have been experienced. Le, Carrel, and Li (2020) and Reibstein, Lovelock, and Dobson (1980) found that satisfaction with public transport services has a positive impact on the frequency of public transport use, while Abou-Zeid and Ben-Akiva (2012) and Beirão and Cabral (2007) observed that a lower satisfaction with car use and a higher satisfaction with public transport use make the use of public transport – or a mode switch from car to public transport – more likely. Finally, travel satisfaction may also affect desire. De Vos et al. (2020a) found that satisfaction with public transport positively affects the desire to travel (more) frequently by public transport. Carrus et al. (2008) found that anticipated positive (or negative) emotions positively (or negatively) affect the desire to use public transport instead of the car to go to work.

In sum, the cycle's five constructs do not only directly influence the next construct, but they also indirectly influence the remaining three constructs (e.g. satisfaction indirectly affects desire, intention and behaviour, through attitude). The cyclical nature of the model infers that none of the five constructs included can be regarded as the start or

end of the cycle. Put differently, they all are the output of one relation (e.g. behaviour is the (direct) output of intention) and the input of another (e.g. behaviour can be regarded as (direct) input of satisfaction). Taken together, the evidence largely supports the main tenet of the TMCC, that travel mode choices in the specified ways are both influenced by and influence attitude, desire, intention, and satisfaction.

Several studies also show effects of the other constructs included in Figure 2. For instance, Bamberg et al. (2003b) found that *perceived behavioural control* (i.e. the perceived ease of frequently using public transport) and *subjective norm* (i.e. significant people's opinions about and support for using public transport) have important impacts on the intention to frequently use public transport. Also, Eriksson and Forward (2011) found that the perceived ease of using bus, bike, or car has effects on the intention to use the mode. However, they found that subjective norm (i.e. the opinions of family and friends on various travel modes) only affects the intention to use the car, but not the intention to travel by bus or bike. Taniguchi and Fujii (2007), on the other hand, did not find any effects of perceived behavioural control and subjective norm (on reducing car use) on the intention to reduce car use. Carrus et al. (2008) showed that, besides effects of perceived behavioural control and subjective norm (regarding public transport use) on the intention to use public transport instead of the car, perceived behavioural control and subjective norm also affected the desire to use public transport.

The ease of performing a certain behaviour is often affected by *opportunities and constraints* (as outlined by Chapin (1974) and Hägerstrand (1970) in activity-travel behaviour research). Opportunity and constraint are closely related to actual behavioural control and facilitating conditions as discussed in the theories of planned behaviour and interpersonal behaviour, respectively. For instance, limited transport opportunities such as not having access to a car or not having (frequent) public transport services in the neighbourhood may result in not being able to drive or use public transport, even though a person might have a desire to use these modes. Long travel distances (often resulting from low levels of neighbourhood density and diversity) are possible barriers for people to walk or cycle, forcing them to use motorised modes, even though they have a desire to travel actively. As a result, opportunities and constraints may moderate the effect of desire on intention. Thus, a person may have a desire to use a certain mode, but limited travel options and existing barriers could result in the intention to use another mode. Furthermore, opportunities and constraints may influence the perceived ease of using a certain mode (perceived behavioural control), and for this reason, intended travel behaviour.

The effect of intention on behaviour may be overridden by *habit*. A person who consciously intends to walk or cycle to the store may drive because of having the habit of driving. New behaviour is usually guided by intention, while behaviour that has (satisfactorily) been repeated many times often becomes habitual (Aarts, Verplanken, & van Knippenberg, 1998; Verplanken, Aarts, & van Knippenberg, 1997). The relationship between habit and intention is therefore reciprocal: the stronger the habit, the weaker the role of intention, and vice versa (Gardner, Lally, & Rebar, 2020; Triandis, 1977). In a stable context, it is likely, that choices are not deliberate (i.e. based on intentions) but script-based (i.e. habitual), that is, no external information about options are searched since the chosen option is directly retrievable from memory (Bamberg et al., 2003a; Gardner, 2009; Gärling, Fujii, & Boe, 2001). Over time, deliberation-based choices become habitual

if repeatedly proven to be satisfactory, or at least adequate. In contrast to deliberate choice, habitual behaviour (resulting from positive reinforcement or the presence of prohibitive constraints) results in reduced cognitive effort since repetition of past behaviour is generally easier, and less risky and time-consuming (Gärling & Axhausen, 2003; Schwanen, Banister, & Anable, 2012).

Although this paper focuses on travel mode choice, the cycle presented in [Figure 2](#) may also be applicable to other travel choices, such as choices related to people's amount of travel (including travel frequency, distance, and duration) (e.g. Ory & Mokhtarian, 2009). For instance, negative travel-liking attitudes (e.g. travel time being perceived as wasted time) may result in a desire to reduce travel time, which in turn can (if not affected by constraints) result in an intention to travel shorter durations. If this intention effectively results in shorter trips, it may affect travel satisfaction positively (as previous studies found negative influences of travel time on satisfaction (Morris & Guerra, 2015a)), which in turn may positively influence travel-liking attitudes and decrease the desire to reduce travel time even further. However, clear differences with the travel mode choice exist, since travel time is a continuous choice without explicit categories (which travel modes have), while the desire and intention are often (yet not always) considered relative since they mostly refer to an increase or decrease rather than a specific duration (Choo et al., 2005).

## 5. Discussion

### 5.1. Policy implications

The TMCC presented in [Figure 2](#) provides new insights into the travel mode choice, and the multiple links between attitude, desire, intention, behaviour, and satisfaction. The cycle also provides valuable information for policymakers about how to increase people's choices of public transport and especially walking and cycling, which are healthier, safer, less polluting, and less space-consuming than private car use. First of all, policymakers and urban planners should try to increase people's satisfaction with public transport and active travel. This can be achieved, for instance, by: (i) improving the on-board experience (e.g. comfort), service delivery (e.g. punctuality), and waiting conditions for public transport users; (ii) creating wide, well-lit sidewalks, and safe zebra crossings with limited waiting time for pedestrians; and (iii) creating separated, barrier-free bicycle lanes and sufficient, high-quality bicycle parking for cyclists (e.g. Susilo & Cats, 2014). Doing so would increase favourable attitudes towards public transport and active travel, which in turn would positively affect the desire and intention to use these modes, as well as their effective use in the future.

Second, policymakers may try to increase people's favourable attitudes towards public transport and active travel. These modes could be actively promoted as being cheaper, safer, healthier, and more environmentally friendly than travel by private car. Directly changing attitudes is, however, difficult (Albarracin & Johnson, 2019). Furthermore, since the theory of cognitive dissonance (Festinger, 1957) posits that people mainly change their attitudes in order to justify their choices (in case of a dissonance between attitude and behaviour), frequent car users are unlikely to have negative car attitudes. As implied by the TMCC, another way of changing attitudes is to make alternative

travel modes more satisfying (as discussed above). Furthermore, when more people will use these travel modes frequently (e.g. by giving more road space to public transport and active travel), the use of these modes will become more accepted and established (especially in car-dominated contexts), which in turn would further positively influence attitudes towards the modes.

Third, the link between desire and intention could be reinforced by increasing the actual control of travel mode choice, i.e. by changing the context such that travel opportunities are increased and travel constraints minimised. Constraints can often distort the link between desire and intention. The intention to use public transport, for instance, may not be strong if public transport service levels are low, despite a desire to use public transport. The residential location is also an important context that can restrict the use of some modes. A person living in a suburban area may have a desire to walk or cycle but have no intention to do so because most destinations are not within walking or cycling distance. As a result, policymakers should enable people with a desire to walk, cycle, or use public transport to effectively travel with these modes by creating opportunities and removing constraints. This can be done by significantly improving the public transport services and infrastructure for pedestrians and cyclists, but also by stimulating people to live in compact urban areas with good facilities for car alternatives; for instance, by making urban areas more attractive to reside in by creating affordable dwellings for different family sizes, green spaces, and low-traffic areas. Previous studies have indicated that a change in the residential context (due to a residential relocation) can be effective in changing travel intentions (Bamberg, 2006; Verplanken, Walker, Davis, & Jurasek, 2008).

Fourth, the link between intention and behaviour can be reinforced by breaking (undesired) habits. In the case of habits, people do not make decisions resulting from a deliberate decision process (i.e. based on intention), but based on past behaviour. For instance, a person having the intention to use public transport (and therefore no objective or subjective constraints are preventing him/her to use this mode) may still decide to use the car, because the car has been used previously for that type of trip. Providing people with additional information (e.g. of existing public transport or cycling routes) or offering them incentives (e.g. a temporary free public transport pass) may strengthen the role of intention, which would increase the likelihood that a car alternative will be chosen. For instance, some studies have found that offering temporary free public transport passes to habitual car users increases the frequency of public transport use (especially during, but also after the treatment period), because it partly breaks car habits (Abou-Zeid & Ben-Akiva, 2012; Fujii & Kitamura, 2003; Thøgersen, 2009).

We acknowledge that the policy recommendations suggested above are not new and have been discussed before. Nevertheless, the TMCC provides additional insights into how policies can impact travel behaviour. We thus argue that most policies will not directly impact the travel mode choice, but that a cycle may be set in motion that can change people's desires and intentions, eventually potentially changing behaviour. Yet, the cycle also indicates that trying to change people's satisfaction levels or attitudes may not have the desired outcome if opportunities/constraints and habits are not addressed. Therefore, policies should not be implemented in isolation, but should make it possible/easier to choose options which are stimulated. For instance, public transport use should not only be stimulated by improving the on-board experience and active promotion, but also by increasing frequency/coverage, and by providing information/

incentives to potential users. Doing so will create more opportunities and limit constraints for using public transport and may break undesired (car) habits, making it possible for those with a desire to travel by public transport to effectively do so.

## 5.2. Future research needs

In order to know whether the TMCC, and the related policy recommendations discussed in the previous section, are valid, the accuracy of the cycle needs to be tested. The model presented in [Figure 2](#) will, however, be difficult to analyse due to its cyclical nature, even when using longitudinal data. First of all, it is essential to have a good understanding of the five main constructs in the cycle (i.e. attitude, desire, intention, behaviour, and satisfaction), how they should be measured, and how they are related with each other. Since intention and desire have been analysed least frequently – mostly by asking respondents to what extent they agree with one or two statements – more fine-grained and reliable scales should be developed. Future studies could then analyse how the five constructs are related to each other by examining how a change in one affects another, while controlling for other constructs. For instance, a regression analysis may assess the effect of intended mode use on actual mode choice, while controlling for travel mode attitudes and desired mode use. In order to measure indirect effects (e.g. from attitude and desire to mode choice, via intention), a structural equation modelling approach is necessary. However, with cross-sectional data, it would be impossible to identify the direction of causality and indicate, for instance, whether mode choice affects travel attitude, attitude affects mode choice, or whether they affect each other. In order to do this, true longitudinal data are needed.

We argue that the best way to investigate the TMCC is to collect data in multiple waves. By doing so, the effect of attitude in wave 1 on desire in wave 2 can be analysed using cross-lagged structural equation models (taking into account possible changes in attitudes between waves 1 and 2, by using stability coefficients). The same can be done for the effects of desire on intention, intention on behaviour, behaviour on satisfaction, and satisfaction on attitude. With two waves, only direct effects can be measured. With three waves, it is also possible to estimate indirect effects of, for instance, attitude on intention through desire. In an ideal scenario, the complete TMCC can be studied in full using five waves. This would enable researchers not only to explore whether effects between constructs are significant, but also to compare the magnitude and relative strengths of effects, something that most previous studies have neglected (mainly because of focusing on only one relation). However, travel-related data with five or more waves are rare (although exceptions exist, see [Clark, Chatterjee, Martin, & Davis, 2020](#); [Klein & Smart, 2017](#); [Kroesen & De Vos, 2020](#)), and – to the best of our knowledge – no longitudinal data including attitude, desire, intention, behaviour, and satisfaction exists at present.

Although it is unclear how long the time between waves should be (given that too long times may result in attenuated effects, while short times may be too short to measure changes), longitudinal data can also provide information about the rates of change in the five constructs. The constructs may change at different rates, since, for instance, satisfaction and intention are assumed to change easier than attitudes and desire, respectively (see [Section 2](#)). However, it is possible that in a stable context the constructs in the

TMCC do not change as people might be able to travel with a desired travel mode (including high satisfaction levels and positive attitudes) or use a particular mode by habit or because certain (permanent) constraints prevent them from using a more preferred/desired mode. Therefore, a quasi-longitudinal design focusing on certain life events or changes in travel context might be more appropriate. One survey prior to and multiple surveys (with several months in between) after events such as a residential relocation, buying/selling a car, buying/receiving a public transport pass, or the implementation of traffic restrictions (e.g. sustainable urban mobility plans, road pricing, low emission zones) or new metro/light rail services can indicate how (fast) travel attitude, desire, intention, behaviour, and satisfaction change due to broken habits and new opportunities and constraints created.

## Notes

1. Although multiple interpretations and definitions of attitude exist, we mainly follow the commonly used definition formulated by Ajzen (1991, p. 188), indicating that an attitude “refers to the degree to which a person has a favourable or unfavourable evaluation or appraisal of the behavior in question”.
2. Although we link preference to attitude, we do acknowledge that preference may also (to a certain extent) be related with desire and intention, since preferences can – in contrast to attitudes – be affected by elements such as perceived behavioural control and constraints. As a result, the alternative with the most positive attitude will not always be the preferred alternative. Furthermore, travel behaviour studies often use the terms stated and revealed preferences to refer to people’s intended and actual behaviour (e.g. Fujii & Gärling, 2003; Hensher, 1994).
3. The question used in the teleportation test is: “if you could snap your fingers or blink your eyes and instantaneously teleport yourself to the desired destination, would you do so?” (Mokhtarian & Salomon, 2001).
4. Although desire and intention are often treated as synonyms, Perugini and Bagozzi (2004) indicate that desires are less performable, less connected to actions, and enacted over longer time frames compared to intentions. For example, bad weather conditions may result in a person having the intention to use a car, although having a desire to cycle.
5. Subtle differences between intention and expectation seem to exist. While intention mainly refers to near upon and certain situations (e.g. travel mode choice for commute trips the next week), expectations often refer to situations which are less certain and further in time. For instance, studies have focused on future expected autonomous vehicle ownership and related changes in travel behaviour (e.g. Nielsen & Haustein, 2018), while others have analysed expected teleworking frequencies or shifts in mode choice after the COVID-19 pandemic (e.g. Conway, Salon, Capasso da Silva, & Mirtich, 2020).
6. Satisfaction is associated with the experience of either transient emotional responses or more enduring moods during an activity episode (such as a trip), as well as a cognitive appraisal of the activity episode. The appraisal information it generates is temporally constrained and vanishes when the person no longer thinks about the activity episode (Clore & Schnall, 2005). As another form of appraisal, attitudes are memory representations of positive or negative evaluations of objects, persons or behaviours that repeatedly may be activated to guide behaviour or choice. An attitude does not automatically disappear when a person stops thinking about the attitude object. Attitudes are thus not constrained by time, although this does not imply that they never change (Ajzen, 1991; Albarracín & Johnson, 2019; Clore & Schnall, 2005; Eagly & Chaiken, 1993).
7. A personality trait can be defined as a predisposition to perform a certain group of behaviours, both directly and indirectly through the influence of attitudes (Ajzen, 2005). A lifestyle

can be defined as an individual's way of living which both affects and is affected by his or her outlook of life and motivations, including beliefs, interests, and general attitudes (Bourdieu, 1984; Weber, 1978).

8. Besides an indirect effect of perceived behavioural control on behaviour (through intention), perceived behavioural control can also directly influence behaviour (as shown by the dashed arrow in Figure 1). For instance, a person who is confident to perform a certain behaviour will probably be more likely to perform that behaviour compared to a person who doubts his/her ability, even though both may have the same intention to perform the behaviour. Furthermore, perceived behavioural control can be used as a substitute of actual behavioural control in case of limited information regarding the behaviour or when new and unfamiliar elements have entered into the situation (Ajzen, 1991).
9. Social factors mainly refer to appropriate and expected behaviours (for persons holding particular positions in a group), and how well a person thinks they can perform a behaviour, and are therefore comparable to social norms and perceived behavioural control described in the theory of planned behaviour.
10. These theories emphasise instead the role of persuasion and behavioural outcomes for the formation and change of attitudes (see e.g. Albarracín & Johnson, 2019).

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