INFLUENCE OF VALUES, ATTITUDES TOWARDS TRANSPORT MODES AND COMPANIONS ON TRAVEL BEHAVIOR

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Submission Date: August, 6, 2019

ABSTRACT

The design and implementation of transport policies to promote active transport requires a deep comprehension of the factors that influence travel behavior. In this context, psychological factors and social interactions play an important role in explaining travel-related decisions. Even though, the importance of psychosocial variables in travel behavior research has been widely recognized during recent years, there is a lack of understanding of how these factors interact. This paper aims to better understand the interrelationships between values, attitudes towards transport modes and a subset of the social network composed by habitual trips and activities companions. For this purpose, a theoretical framework is proposed which posits all the possible relationships among these factors. In order to test this conceptual framework, two Structural Equation Models are estimated considering attitudes towards active transport (bike and walking), using a dataset from a web-based survey developed for the MINERVA project in Valencia (Spain). The data is composed by 404 respondents who provided valid information regarding all the variables of the study. Results confirm the hierarchical value-attitude-behavior structure while several effects are also found directly between values and attitudes. For instance, individuals who attach more importance to Stimulation and Achievement values are higher active transport user, while values traditionally associated with car use are no longer maintaining this relation. Besides that, positive attitudes towards walking and cycling are strongly associated with a higher use of active transport, and also seem to discourage the use of motorized modes. Several characteristics of companions affects personal values and active travel and less influence is found on attitudes. These findings are useful to develop transport policies and campaigns to promote sustainable transport, such as the design of strategies in the context of Travel Behavior Change Programs. Limitations of this research include several aspects related to online surveys, for instance, sample size and underrepresentation of individuals over 55 years.

Keywords: travel behavior, values, attitudes, companions, SEM.

INTRODUCTION

In recent years, concerns about environmental damage has arisen, caused by transport externalities, in particular carbon emissions and noise levels. To alleviate this problem, policy measures target the reduction of private transportation use by promoting public transportation and active transport. These measures would also help making urban traffic more fluid and reduce emissions (Gardner *et al.*, 2010; Thomas *et al.*, 2014)

On the other hand, the prediction of individual's response is an essential component of transportation planning and policy analysis. The ultimate mission of travel demand forecasting is to develop the capability to predict how individuals respond to changes in their travel environment (Kitamura, 1998). Such predictions are based on a set of factors that influence travel behavior. In particular, they are needed to understand how travelers react to the implementation of both hard (i.e., car-use restrictions) and soft (i.e., awareness campaigns) transportation measures (Taniguchi and Fujii, 2010; Gärling and Fujii, 2009).

The relevance of psychosocial factors as explanatory variables in travel demand forecasting models has been acknowledged by a large number of studies (e.g. Dijst *et al.*, 2008; Klöckner and Matthies, 2009). Similarly, the influence of social networks on mobility has been recognized (Kim *et al.*, 2017).

Personal values and travel behavior

Less attention has been paid to personal values, which can be defined as evaluations of abstract ideas (e.g., social order or equality) in terms of their importance as guiding principles in people's life (Rokeach, 1993; Schwartz, 1992). According to Schwartz (1992) , values express ten types of motivation: achievement (the goal of personal success through demonstrating competence according to social standards), benevolence (preservation and enhancement of the welfare of the people you're in frequent personal contact with), conformity (restraint of any actions, inclinations, and impulses that are likely to upset or harm others and violate social expectations or norms), hedonism (taking pleasure or sensuous gratification for yourself), power (social status and prestige. It involves control or dominance over people and resources), security (safety, harmony, and stability of society, of your relationships, and of yourself), self-direction (goal for independent thought and action. Those who value self-direction often find themselves choosing, creating, and exploring), stimulation (search for excitement, novelty, and challenge in life), tradition (respect, commitment, and acceptance of the customs and ideas that traditional culture or religion provide) and universalism (understanding, appreciation, tolerance, and protection for the welfare of all people and for nature). These values can be plotted in a circumflex structure to form four higher order value domains: conservation, openness to change, self-enhancement and self-transcendence. One dimension contrasts conservation values (e.g., national security) against openness values (e.g., freedom), whereas the other dimension contrasts self-enhancement (e.g., power) against self-transcendence values (e.g., helpfulness). Because values are abstract, they have the potential to influence many different attitudes.

Only a few authors have studied the influence of personal values on travel behavior and attitudes. Paulsen *et al.* (2014) adopted the value–attitude–behavior hierarchy proposed by Homer and Kahle (1988) to study travel mode choice. They confirmed Homer and Kahle's framework, and found that hedonism, security and power influence attitudes towards flexibility, convenience and comfort, and car ownership.

Hunecke *et al.* (2010) found that self-enhancement negatively influenced bike use, whereas openness to change positively affected the use of public transport. Lind *et al.* (2015) used cluster analysis and hierarchical logistic regressions to differentiate car versus active travelers. De Groot and Steg (2008) found that awareness of consequences was positively associated to be in the active

travelers' group. In contrast, ascription of responsibility was negatively associated to be in the active travelers' group.

Nordlund and Garvill (2003) studied willingness to reduce car use, and found that self-transcendence and ecocentrism, directly influence problem awareness concerning biosphere and humankind, and personal norms concerning car use reduction.

Nordlund and Westin (2013) found that openness to change vs. conservation, and self-transcendence vs. self-enhancement, directly influence environmental concerns. They also found a direct influence of openness to change vs. conservation on the intention to travel by a new railway line under construction.

Pojani *et al.* (2018) studied the intentions to use car, bus and bicycle using lifestyle orientations that include some personal values. Lifestyle orientations towards equality and materialism were found to indirectly and positively influence the intention to use cars. The former indirectly and negatively influence the intention to use the bus. With respect to bike use, equality was indirectly and positively related to the intention to cycle, but materialism directly and negatively affected the intention to cycle.

García *et al.* (2019) studied the relations between values, attitudes towards transport modes and travel intentions to use active transport, and actual behavior and found that openness to change and self-transcendence values are associated to cycling and walking. This research contributes to a further understanding of the interrelationships among these variables thanks to the use of Structural Equation Models and including actual behavior of different modes (public transport and private vehicle).

Attitudes and travel behavior

Attitudes can be described as "global and relatively stable evaluations that people do about persons, things or ideas" (Morales *et al.*, 2007). Thus, attitudes are related to positive or negative views that people have regarding any aspect of reality (Eagly and Chaiken, 1993). Travel behavior literature has long recognized the role of attitudes and preferences, and many studies have concluded that attitudes play a significant role on influencing travel behavior (Hunecke *et al.*, 2010; Ye and Titheridge, 2017). Some studies incorporate attitudes to study the influence of environmental awareness and sustainability concerns (Alemi *et al.*, 2017; Liua *et al.*, 2017). Additionally, attitudes have been widely used to study the impact of certain policy measures or infrastructure implementation, considering also intentions and its relation with behavior (De Groot and Steg, 2007). Specifically, some studies have found significant direct relationships between attitudes towards characteristics of travel modes and travel behavior (Abrahamse *et al.*, 2009; Muñoz *et al.*, 2013).

Social networks and travel behavior

The term social environment refers to the way people affect the thoughts, feelings and behaviors of others. It includes the culture, the institutions, and the people with whom individuals interact (Casper, 2001). Social interactions are considered in travel behavior studies through the study of Social Networks. Axhausen (2006) defines a Social Network as a set of persons who are linked pairwise, so each person can reach any other through an active tie. In travel behavior research, egocentric analysis is commonly used to study social networks, in which the respondent reports about the characteristics and their relationship with their contacts (Carrasco *et al.*, 2008).

In this study, we focus on social interactions considering those members of the Social Network who share activities and travels with the respondent. We hypothesize that these activity-travel companions are the most influential individuals concerning the respondents' travel behavior. Several studies acknowledge the importance of including companions in transport research, such as transport demand studies (Vovsha *et al.*, 2003), activities duration and moment

of execution (Srinivasan and Bhat, 2008), type of companion (Ho and Mulley, 2013) and activities rescheduling (Ruiz and Habib, 2016).

RESEARCH FOCUS AND CONCEPTUAL FRAMEWORK

As stated above, the influence of values, attitudes towards transport modes and companions has been outlined in transportation research. However, these factors have been studied separately without considering the possible interrelationships among them. Taking these considerations into account, the following theoretical framework is proposed in order to consider these possible relations.

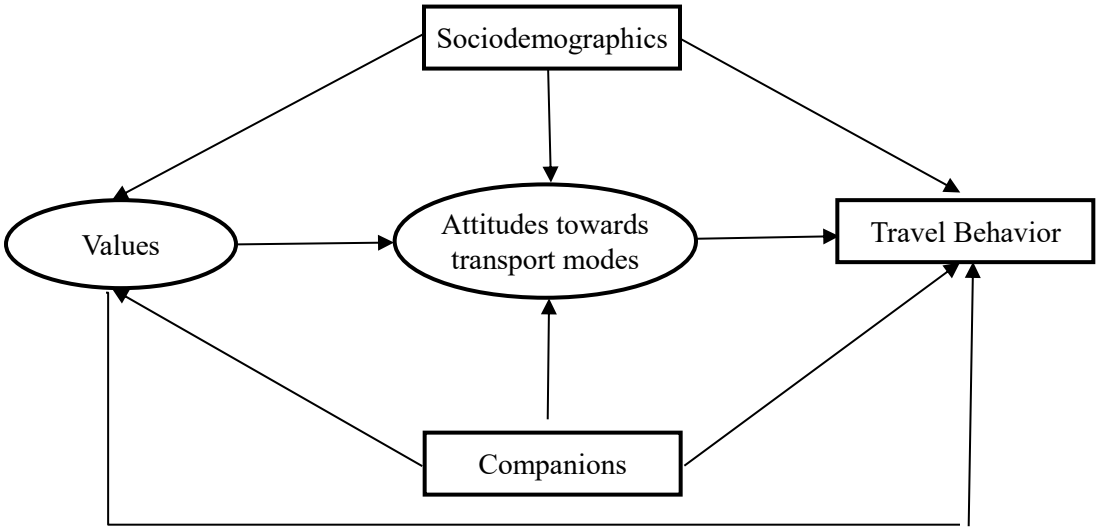

Figure 1 Conceptual model

Particularly, the aim of the paper is to examine the interrelationship between values, attitudes towards transport modes and companions, also including sociodemographic characteristics. This structure is developed following the value-attitude-behavior hierarchical structure proposed by Homer and Kahle (1988), which postulates that values influence attitudes while attitudes influence behavior. Additionally, the direct relation between values and behavior is considered, following the structure proposed by several authors (e.g. Kristiansen and Hotte, 1996).

Lastly, it is hypothesized that companions and sociodemographic characteristics influence travel behavior as well as values and attitudes towards transport modes. These hypothetical relations are included in the value-attitude-behavior hierarchical structure.

Travel Behavior is represented by the use of transport modes, obtained through the activity-and-travel diary of the survey, the mode split is represented with the variables: %PV (Percentage of the trips made by Private Vehicle), %PT (Percentage of the trips made by Public Transport) and %ACTIVE (Percentage of the trips made by Active Transport: walking and cycling).

Companions represents a subset of the social network composed by those individuals we whom we share activities and trips. In the activity-and-travel diary, respondents were asked to report the companions of each episode as well as several attributes about their relationship and the companions' characteristics.

Figure 1 represents the general framework proposed to study these relationships among the variables of the study. Further details of the variables used to measure each of these dimensions are

described in the Variables and Measurements section.

HYPOTHESES

Considering the conceptual framework presented above, several hypotheses are formulated:

- H1. Personal values are related to the use of transport modes.
  - H1a. Personal values Conformity-Tradition, Power and Security are associated positively with the use of private vehicle and negatively with the use of public transport and active modes.
  - H1b. Personal Values Universalism, Stimulation and Achievement are negatively associated with the use of private vehicle and positively associated with the use of public transport and active modes.
- H2. Personal values are related to attitudes towards active modes.
  - H2a. Personal values Conformity-Tradition, Power and Security are negatively associated attitudes towards active modes.
  - H2b. Personal Values Universalism, Stimulation and Achievement are positively associated with attitudes towards active modes.
- H3. Attitudes towards transport modes are related with the current use of these modes.
  - H3a. Positive attitudes towards walking are positively associated with the use of active transport modes and public transport and negatively associated with the use of private vehicle.
  - H3b. Positive attitudes towards cycling are positively associated with the use of active transport modes and public transport and negatively associated with the use of private vehicle.
- H4. Personal values, sociodemographic variables and attributes of activity-and-trip companions influence attitudes towards active modes.
- H5. Sociodemographic variables and attributes of activity-and-trip companions are associated with personal values.

METHODS

Survey Description and Data Collection

The dataset used for this research is part of the MINERVA project. A web-based survey was developed ad-hoc for this project in order to gather information regarding values, and activity-travel related behaviors, attitudes, perceptions, and characteristics of companions (Arroyo *et al.*, 2018). The data collection took place as main area in Valencia (Spain) between May and October 2017 (excluding August). The web-based survey was comprised of five parts. Firstly, a brief questionnaire requested information regarding sociodemographic characteristics, transport accessibility and attributes of the built environment. Secondly, a two-day activity-travel diary collected all the activities and trips performed during a weekday and one day of the week-end, considering main attributes of the episodes (activity type or transport mode, start time and duration, etc.) . In addition, participants were asked to list the companions with whom they carried out each episode. The third section collected basic information of each of the companions previously declared. For instance, demographic information and attributes of the relationship

between each companion and the respondent (frequency of face-to-face meetings and communications, geographical distance, type of relation, etc.) (Table 1). Additionally, respondents were asked to enlarge the list of companions, including those people with whom they share trips and activities regularly who were not included in the activity-travel diary. The fourth part collected information regarding personal values. Finally, the fifth part consisted on a survey regarding attitudes and perceptions. Further details of those parts of the survey included in this research are presented below.

Variables and Measurements

The variables considered in this study are presented in Table 1. In this research, the social network consists of a subset defined by companions of trips and activities, as obtained from the two-day activity-travel diary. Additionally, respondents were asked to enlarge the list of companions, including those people with whom they share trips and activities regularly, but were not included in the activity-travel diary. For instance, demographic information and attributes of the relationship between each companion and the respondent (frequency of face-to-face meetings and communications, geographical distance, type of relation, etc.). Several indicators were built to estimate the aggregated characteristics of the companions for each respondent (Table 1).

The Schwartz Value Scale (SVS), which is based on Schwartz theory of human values (Schwartz, 1992) was used. We have used a Spanish version of the SVS (Balaguer *et al.*, 2006), which is composed by 56 items, each one followed by a brief description for clarification. Some examples of the items are: Equality (equal opportunity for all); Inner harmony (at peace with myself); Social power (control over others, dominance); Pleasure (gratification of desires).The survey evaluates 10 different value types and four values of higher order types. Responses are measured on a nonsymmetrical scale from -1 to 7.

16 items were included in the web-survey to measure attitudes towards each active transport mode (walk and bike), including cognitive (i.e. “it suits my needs”, “it’s comfortable”), affective (i.e. “I like it, it's relaxing”) and behavioral aspects (“I choose this travel mode considering the pollution it might cause”, “I choose this travel mode considering other people’s influence and needs”), and using a 5-point Likert scale. Several items were removed after factorial analysis as it is described later in this paper.

1 **TABLE 1 Definition of variables**
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Variables	Description	Type
SOCIODEMOGRAPHICS		
Gender	0=male; 1=female	Categorical
Age	Age of the respondent	Continuous
Transport _Pass	1=respondent has an integrated public transport pass; 0=otherwise	Categorical
Car	Car availability (0=low to 5=high)	Continuous
Bike	Bicycle availability (0=low to 5=high)	Continuous
Motorbike	Motorbike availability (0=low to 5=high)	Continuous
Bikes in HH	Number of bicycles available in the household	Continuous
Cars in HH	Number of cars available in the household	Continuous
Marital status	1=single; 2=married; 3=civil partner; 4=couple; 5=widow; 6=divorced; 7=other	Categorical
Education level	1=no studies; 2=primary level; 3=vocational training; 4=secondary level; 5-6=higher education; 7=university degree or higher	Categorical
Occupation	1=student; 2=employed; 3=self-employed; 4=student and employed; 5=unemployed; 6=retired; 7=housekeeper; 8=other	Categorical
Income	1=any income; 2=less than 500€; 3=500-1000€; 4=1000-1500€; 5=1500-2000€; 6=2000-2500€; 7=2500-3000; 8=more than 3000 (net monthly)	Categorical
MODE SPLIT (Activity-travel diary)		
%PV	Percentage of the trips made by Private Vehicle	Continuous
%PT	Percentage of the trips made by Public Transport	Continuous
%ACTIVE	Percentage of the trips made by Active Transport (walking and cycling)	Continuous
BICYCLE USE		
Bike_transport	1=bicycle used mainly for travel; 0=otherwise	Categorical
Bike_sport	1=bicycle used mainly for sport; 0=otherwise	Categorical
ACCESIBILITY TO TRANSPORT MODES		
Bike lane	1= bicycle lane available in the respondent's residence area; 0=otherwise	Categorical
Metro	Walking distance to the closest metro station. 1=less than 5 min; 2=5-10 min; 3=10-15 min; 4=15-20min; 5=20-30min; 6=more than 30 min	Categorical
Bus	Distance to the closest bus stop. 1=less than 5 min; 2=5-10 min; 3=10-15 min; 4=15-20min; 5=20-30min; 6=more than 30 min	Categorical
COMPANIONS		
SN_size	Number of companions	Continuous
SN_%male	Percentage of males in the companions	Continuous
SN_%family	Percentage of family members companions	Continuous
SN_%other	Percentage of not family members companions	Continuous
SN_distance	Average distance of residence between the respondent and his/her companions	Continuous
SN_meetings	Frequency of face-to-face meeting with companions	Continuous
SN_age	Average age of companions	Continuous
SN_connectivity	Connection degree among companions (0=low to 5=high)	Continuous
HH_minors	Number of persons under 18 living in the household	Continuous
HH_members	Number of people living in the household	Continuous
SN_influence	Average degree of influence of companions in the ego's mobility	Continuous

RESULTS

This section includes the description of the sample and travel characteristics. Next, descriptive analyses as well as the validation of scales and reliability of constructs are presented. Finally, the Structural Equation Modeling is described. SPSS software was used for descriptive analyses, while MPlus was chosen for Confirmatory Factor Analysis and model estimation.

Sample Characteristics

404 respondents provided valid information to all five parts of the survey after validation and cleaning. The distribution of the sample according to gender is reasonable balanced (Table 2). However, according to age, those over 50 years old are under-represented in the sample. Participants are predominantly students and employed individuals.

The average number of activities and trips per person and per day are 11.4 and 3.9, respectively (Table 3). Regarding active transportation, walking is predominant (45.2%), while the cycling proportion is much lower (6.8%). Among the motorized travel modes, the use of private vehicle is the most predominant (35.6%) and public transport represents 11.7% of the trips. 44.2% of the trips were carried out during week days and 55.8% during week-ends. 54.3% of the trips were executed with companions.

TABLE 2 Sample distribution

	Respondents	Percentage
GENDER		
Male	182	45.1%
Female	222	54.9%
AGE		
16-25	144	35.6%
26-35	100	24.7%
36-50	102	25.2%
>50	58	14.3%
OCCUPATION		
Student	141	34.9%
Employed	188	46.5%
Student & employed	40	9.9%
Unemployed	19	4.7%
Retired	7	1.7%
Other	9	2.2%

The average number of companions reported was 10.18 people per respondent. However, only those who completed the questionnaire were considered, which reduces this ratio to 9.12 companions per respondent. 76% out of those were included in the diary, and the rest were added later and not linked to any activity-travel episode. 31% of companions are family members, 37.4% are friends, 6.4% are partners and the remainders consists of acquaintances and coworkers.

TABLE 3 Modal split and companions

	Trips	Trips/ person	Trips/ person-day	Percentage
MODAL SPLIT				
Private Vehicle	1132	2.802	1.401	35.62%
Public Transport	372	0.921	0.460	11.71%
Cycling	217	0.537	0.269	6.83%
Walking	1437	3.557	1.778	45.22%
Other	20	0.050	0.025	0.63%
COMPANIONS				
Trips with companions	1453	3.60	1.80	45.72%
Solo trips	1725	4.27	2.13	54.28%
Total	3178	7.87	3.93	100%

Descriptive analysis and Scale Reliability: Attitudes towards Transport Modes and Values

Descriptive analyses are carried out and measures of normality, symmetry and kurtosis are obtained for the items that measure attitudes towards transport modes. Some of the items present signs of asymmetry and non-normality, which led us to select more robust models to take such deviations into account for the model estimation.

Cronbach's alpha is used to measure internal consistency, which indicates how closely related a set of items is as a group. The obtained measurements of Cronbach's Alpha for attitudes towards transport modes are acceptable for all the factors (attitudes towards using car = 0.83; attitudes towards cycling = 0.89; attitudes towards public transport = 0.79; attitudes towards walking = 0.75). Thus, the scale reliability can be assumed. Similarly, Cronbach's Alpha for the 10 variables measuring values are acceptable (Conformity = 0.77; Tradition = 0.63; Universalism = 0.85; Stimulation = 0.90; Achievement = 0.77; Power = 0.80; Security = 0.70; Benevolence = 0.97; Hedonism = 0.65; Self-direction = 0.72).

The Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) is used to determine the proportion of variance in the variables that might be caused by the underlying factors. High values are obtained (> 0.9), which indicate that the factor analysis technique may be appropriate. Bartlett's test of sphericity is assessed and a null value was obtained, which also supports the use of factor analysis. Pearson's correlation matrix shows a high correlation between the latent variables. Therefore, these correlations are later included in the formulation of the model.

Next, Exploratory Factor Analyses (EFA) are conducted based on the theoretical constructs that represents attitudes and values. Varimax rotation is used and a factor loading of 0.40 is selected as the threshold to maintain items in the factor.

Last, several Confirmatory Factor Analysis (CFA) specifying the posited relationships of the observed indicators to the latent variables are conducted iteratively. Several iterations are executed considering different sets of the 10 values, as not all of them provide significant results. Final CFA for each of the models are presented below (Tables 4 and 5).

TABLE 4 Confirmatory Factor Analysis. Model 1

	Estimates	S.E.	Est/S.E	P-Value
Attitudes towards cycling				
C_BIKE4	0.746	0.029	25.662	0.000
C_BIKE9	0.664	0.034	19.617	0.000
C_BIKE14	0.787	0.024	32.650	0.000
C_BIKE24	0.419	0.047	8.904	0.000
C_BIKE29	0.658	0.036	18.511	0.000
A_BIKE34	0.590	0.040	14.622	0.000
A_BIKE39	0.783	0.029	26.990	0.000
A_BIKE44	0.437	0.045	9.645	0.000
A_BIKE49	0.699	0.034	20.728	0.000
A_BIKE54	0.471	0.047	9.997	0.000
B_BIKE64	0.403	0.043	9.295	0.000
B_BIKE69	0.541	0.042	12.808	0.000
B_BIKE74	0.617	0.036	17.115	0.000
B_BIKE79	0.429	0.047	9.154	0.000
Achievement				
ACHI34	0.686	0.037	18.451	0.000
ACHI39	0.498	0.056	8.865	0.000
ACHI55	0.844	0.029	28.906	0.000
Stimulation				
STIMU9	0.768	0.031	24.643	0.000
STIMU25	0.817	0.031	25.949	0.000
STIMU37	0.716	0.035	20.434	0.000
Security				
SECUR8	0.461	0.062	7.473	0.000
SECUR13	0.443	0.060	7.329	0.000
SECUR15	0.464	0.052	8.837	0.000
SECUR22	0.512	0.049	10.504	0.000
SECUR42	0.464	0.052	8.847	0.000
SECUR56	0.611	0.045	13.547	0.000
Universalism				
UNIVER17	0.594	0.048	12.293	0.000
UNIVER24	0.617	0.051	12.182	0.000
UNIVER26	0.588	0.044	13.219	0.000
UNIVER29	0.592	0.040	14.653	0.000
UNIVER30	0.410	0.074	5.516	0.000
UNIVER35	0.444	0.051	8.732	0.000
UNIVER38	0.616	0.048	12.879	0.000

Note. Goodness of FIT: Chi-Square/df = 746.590/462, CFI = 0.933, TLI = 0.924, SRMR = 0.037, REMSEA = 0.051

TABLE 5 Confirmatory Factor Analysis. Model 2

	Estimates	S.E.	Est/S.E	P-Value
Attitudes towards walking				
C_WALK5	0.584	0.050	11.576	0.000
C_WALK15	0.663	0.039	16.837	0.000
C_WALK30	0.454	0.053	8.610	0.000
A_WALK35	0.533	0.057	9.346	0.000
A_WALK40	0.693	0.047	14.615	0.000
A_WALK50	0.530	0.057	9.357	0.000
B_WALK60	0.790	0.274	2.884	0.004
Universalism				
UNIVER17	0.631	0.040	15.666	0.000
UNIVER24	0.642	0.042	15.250	0.000
UNIVER26	0.570	0.043	13.241	0.000
UNIVER29	0.584	0.037	15.816	0.000
UNIVER30	0.501	0.060	8.411	0.000
UNIVER35	0.461	0.053	8.691	0.000
UNIVER38	0.577	0.044	13.101	0.000
Stimulation				
STIMU9	0.784	0.034	23.357	0.000
STIMU25	0.829	0.034	24.283	0.000
STIMU37	0.691	0.037	18.720	0.000
Conformity-Tradition				
CONFOR11	0.538	0.048	11.294	0.000
CONFOR20	0.556	0.047	11.842	0.000
CONFOR40	0.658	0.045	14.548	0.000
CONFOR47	0.666	0.037	18.099	0.000
TRADI18	0.509	0.046	10.951	0.000
TRADI36	0.516	0.049	10.480	0.000
TRADI44	0.486	0.049	9.966	0.000
TRADI51	0.423	0.051	8.335	0.000
Power				
POWER3	0.524	0.069	7.546	0.000
POWER12	0.550	0.052	10.648	0.000
POWER23	0.614	0.062	9.954	0.000
POWER27	0.684	0.061	11.258	0.000
POWER46	0.566	0.057	9.906	0.000

Note. Goodness of FIT: Chi-Square/df = 671.154/377, CFI = 0.905, TLI = 0.890, SRMR = 0.060, REMSEA = 0.044

Model Estimation and Results

Structural Equation Modelling (SEM) was used to examine the interrelationships between the constructs.

In this study, maximum likelihood with Huber–White covariance adjustment (MLR) was used for parameter estimation (Hox and Bechger, 1993). This estimator uses White's sandwich-based method to yield test statistics that are robust in the presence of non-normality and non-independence. While this robust estimator yields superior results (compared to standard

maximum likelihood) when input data are non-normal, the chi-square test of absolute model fit can still be sensitive to trivial misspecifications in the model's structure. Additionally, we also have evaluated the following descriptive measures of model fit: the Standardized Root Mean Residual (SRMR) (Hu and Bentler, 1999), the Comparative Fit Index (CFI) (Browne and Cudeck, 1992) and the Root Mean Square of Approximation (RMSEA) (Bollen, 1989) using the recommended cutoff values of 0.90 for the CFI and related incremental fit indices, 0.80 for the RMSEA, and 0.10 for SRMR (Vandenberg and Lance, 2000).

Based on the conceptual framework and the results of the measurement parts of the models (CFA), two full SEM models were estimated.

Model 1: Attitudes towards cycling, values, companions, sociodemographics and use of transport modes

Model 1 (Figure 2) focuses on the interrelationships between attitudes towards cycling, values, companions and the use of transport modes: private vehicle (PV,) public transport (PT) and active transport (AT).

Goodness of fit indexes are assessed: Chi-Square/df = 10628.601/1134, Comparative Fit Index (CFI) = 0.867, Tucker Lewis Index (TLI) = 0.855, Standardized Root Mean Square Residual (SRMR) = 0.078 y Root Mean Square Error of Approximation (REMSEA) = 0.043. Even though CFI and TLI values do not reach 0.9, the goodness of fit is considered appropriate considering the rest of the parameters.

Taking into account the effects of personal values on attitudes towards cycling, several significant results are found. Stimulation is associated positively with attitudes towards cycling, while Security is negatively related to this type of attitudes.

Next, the rest of the variables that might influence attitudes towards cycling are considered. No relation related to the influence of companions and sociodemographic characteristics is found significant, except for car availability that provide a negative association with bike use.

Considering now the factors that affect values, several significant relations are found. Bike availability is associated positively with Universalism, while gender (males) is found significant and negatively associated with Security. Additionally, bike availability is positively associated with Stimulation, whereas average age of companions and Stimulation are linked negatively. Last, car availability and employed individuals are connected by a significant and negative association with Achievement.

Focusing on travel behavior, the proposed relations between attitudes towards cycling and mode split are confirmed. A negative and significant relationship is found between attitudes towards cycling and use of private vehicle. This relation is found positive for active transport modes, while no effect is obtained in the case of public transport.

Results confirm that values also influence the use of transportation modes directly. Security is related positively with public transportation use and negatively with active modes. The association between Universalism and public transportation use is also significant and negative. Lastly, Stimulation is positively and significantly related with active modes. However, Achievement is not directly related with mobility.

Because the results of the relationship between sociodemographic characteristics and companions and travel behavior tends to be the same for both models, these results will be discussed later.

TABLE 4 Results of SEM model. Model 1

	Estimates	S.E.	Est/S.E	P-Value
Effects on attitudes towards cycling				
Stimulation	0.366	0.053	6.933	0.000
Security	-0.233	0.058	-4.005	0.000
Car	-0.083	0.050	-1.669	0.095
Effects on Universalism				
Bike	0.158	0.055	2.862	0.004
Effects on Stimulation				
SN_age	-0.222	0.049	-4.516	0.000
Bike	0.250	0.054	4.607	0.000
Effects on Security				
SN_male	-0.101	0.053	-1.929	0.054
Bike_transport	-0.222	0.055	-4.020	0.000
Efects on Achievement				
Car	-0.109	0.047	-2.306	0.021
Employed	-0.182	0.050	-3.652	0.000
Effects on Private Vehicle use (PV)				
Attitudes towards cycling	-0.133	0.045	-2.962	0.003
SN_%others	-0.170	0.045	-3.750	0.000
SN_male	0.116	0.035	3.261	0.001
SN_distance	0.272	0.052	5.215	0.000
SN_meetings	0.209	0.060	3.460	0.001
SN_communications	-0.080	0.036	-2.232	0.026
Car	0.358	0.038	9.363	0.000
Effects on Public Transport use (PT)				
Universalism	-0.138	0.043	-3.186	0.001
Security	0.122	0.063	1.952	0.051
SN_male	-0.129	0.047	-2.752	0.006
Car	-0.279	0.049	-5.649	0.000
Effects on Active Transport use (AT)				
Attitudes towards cycling	0.123	0.053	2.335	0.020
Stimulation	0.137	0.046	2.978	0.003
Security	-0.147	0.049	-2.993	0.003
SN_%others	0.113	0.048	2.328	0.020
SN_closeness	-0.063	0.028	-2.278	0.023
SN_distance	-0.297	0.057	-5.179	0.000
SN_meetings	-0.134	0.056	-2.382	0.017
HH_members	-0.053	0.028	-1.885	0.059
Car	-0.170	0.047	-3.624	0.000
Bike_sports	-0.152	0.042	-3.636	0.000

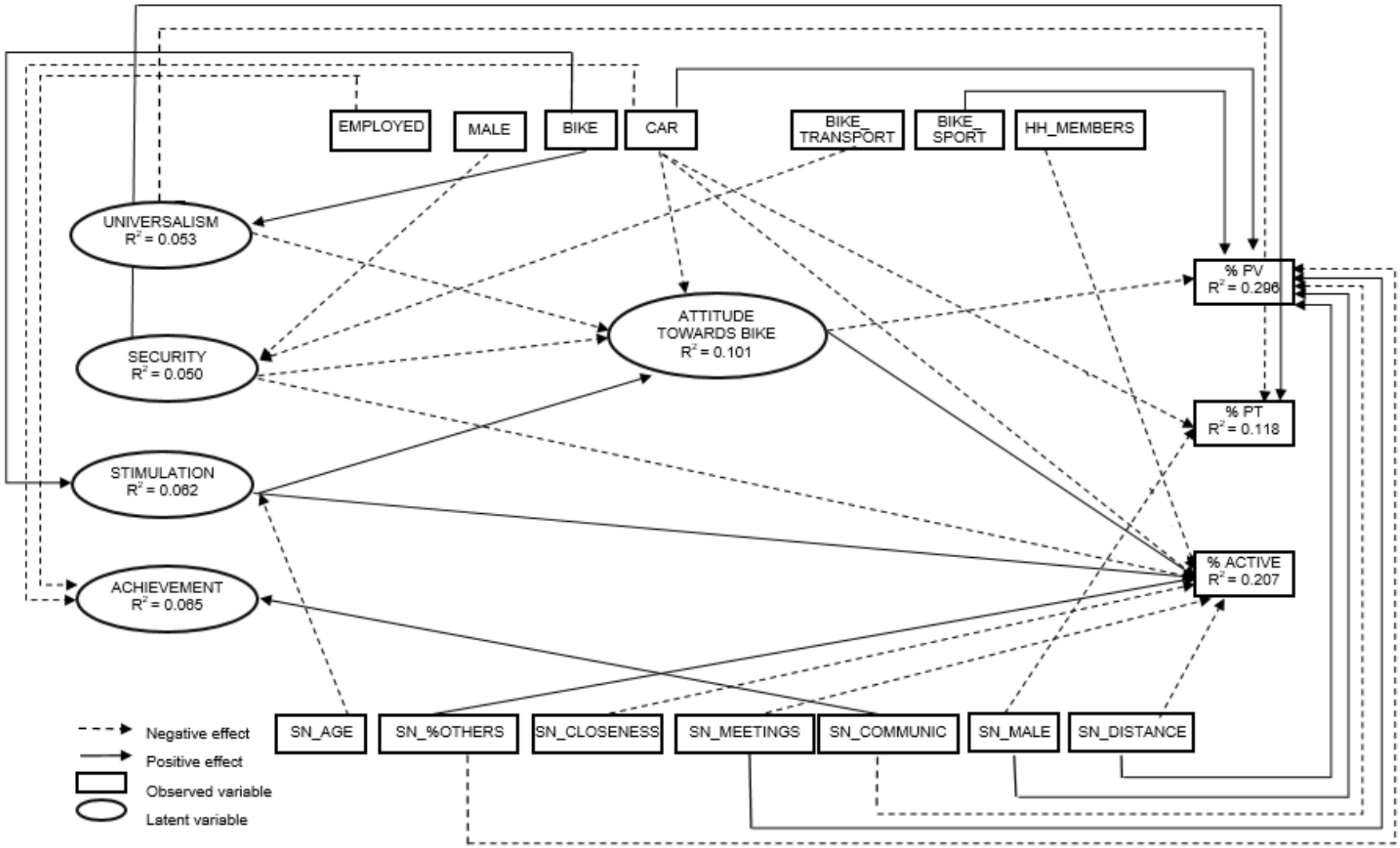

Figure 2 Model 1. Results of SEM model including relations among attitudes towards cycling, values, companions, sociodemographics and mode split.

Model 2: Attitudes towards walking, values, companions, sociodemographics and use of transport modes

Model 2 (Figure 3) includes the interrelationships between attitudes towards walking, values, companions and the use of transport modes: PV, PT and active transport (walking and cycling).

Goodness of fit of the model is assessed following the criteria explained above. Results indicate an appropriate fit of this model: Chi-Square/df = 1345.814/957, Comparative Fit Index (CFI) = 0.904, Tucker Lewis Index (TLI) = 0.895, Standardized Root Mean Square Residual (SRMR) = 0.051 and Root Mean Square Error of Approximation (REMSEA) = 0.031.

Considering the effects of values on attitudes towards walking, several significant associations are found in this model. Universalism is associated positively with attitudes towards walking, whereas Power is found negatively related to this variable.

Taking into account now the factors that might influence attitudes towards walking, several significant relations can be observed. The number of companions, number of minors in the house hold and bike lane availability in the area of residence are associated positively with attitudes towards walking. A negative association is also found between motorbike availability and this attitudes.

Next, the influence of sociodemographic factors and companions characteristics on values is addressed. A positive significant relation between bike availability and Universalism is found, whereas the percentage of men among companions, average distance of residence to companions and bike lane presence in the neighborhood are related negatively with Universalism. Similarly, the percentage of non-family members among companions, married individuals and bike lane availability are related positively with Power. Lastly, married individuals are also associated positively with Power while distance of residence of companions is related negatively with this value.

In this model, interesting relations are found between attitudes and travel behavior as well. Attitudes towards walking provide a significant and negative association with car and public transportation use, while this relation is found positive when considering active modes.

Focusing on the influence of values on travel behavior directly, several significant associations are found. Conformity-Tradition is associated significantly with a negative sign with the use of active transportation while Stimulation is related positively with active transportation.

TABLE 5 Results of SEM model. Model 2

	Estimates	S.E.	Est/S.E	P-Value
Effects on attitudes towards walking				
Universalism	0.217	0.051	4.245	0.000
Power	-0.158	0.058	-2.716	0.007
SN_size	0.093	0.040	2.314	0.021
Moto	-0.111	0.051	-2.189	0.029
HH_minors	0.122	0.047	2.593	0.010
Bikelane	0.117	0.062	1.887	0.059
Effects on Universalism				
Bikelane	-0.091	0.049	-1.871	0.061
Bike	0.170	0.055	3.072	0.002
SN_gender	-0.102	0.050	-2.036	0.042
SN_distance	-0.122	0.056	-2.199	0.028
Effects on Stimulation				
Bike	0.220	0.049	4.496	0.000
SN_age	-0.190	0.051	-3.742	0.000
Effects on Conformity-Tradition				
Married	0.140	0.049	2.825	0.005
SN_distance	-0.146	0.052	-2.815	0.005
Effects on Power				
Bikelane	0.102	0.053	1.946	0.052
Married	0.235	0.057	4.094	0.000
SN_%others	0.143	0.052	2.732	0.006
Effects on Private Vehicle use (PV)				
Attitudes towards Walking	-0.130	0.053	-2.441	0.015
SN_%others	-0.185	0.043	-4.349	0.000
SN_gender	0.112	0.035	3.169	0.002
SN_distance	0.291	0.053	5.509	0.000
SN_meetings	0.216	0.061	3.576	0.000
SN_communications	-0.088	0.036	-2.461	0.014
Car	0.328	0.041	8.022	0.000
Employed	0.051	0.030	1.677	0.094
Bike_sports	0.146	0.044	3.308	0.001
Effects on Public Transport use (PT)				
Attitudes towards Walking	-0.126	0.052	-2.417	0.016
SN_gender	-0.129	0.048	-2.720	0.007
Car	-0.296	0.049	-6.056	0.000
Bike_transport	-0.091	0.044	-2.072	0.038
Effects on Active Transport use (AT)				
Attitudes towards Walking	0.212	0.052	4.087	0.000
Stimulation	0.095	0.041	2.312	0.021
Conformity & Tradition	-0.112	0.040	-2.793	0.005
SN_%others	0.115	0.048	2.412	0.016
SN_closeness	-0.068	0.029	-2.305	0.021
SN_distance	-0.336	0.061	-5.509	0.000
SN_meetings	-0.148	0.058	-2.550	0.011
HH_members	-0.053	0.030	-1.723	0.085
Car	-0.154	0.048	-3.227	0.001
Bike_transport	0.111	0.033	3.355	0.001
Bike_sports	-0.104	0.044	-2.371	0.018

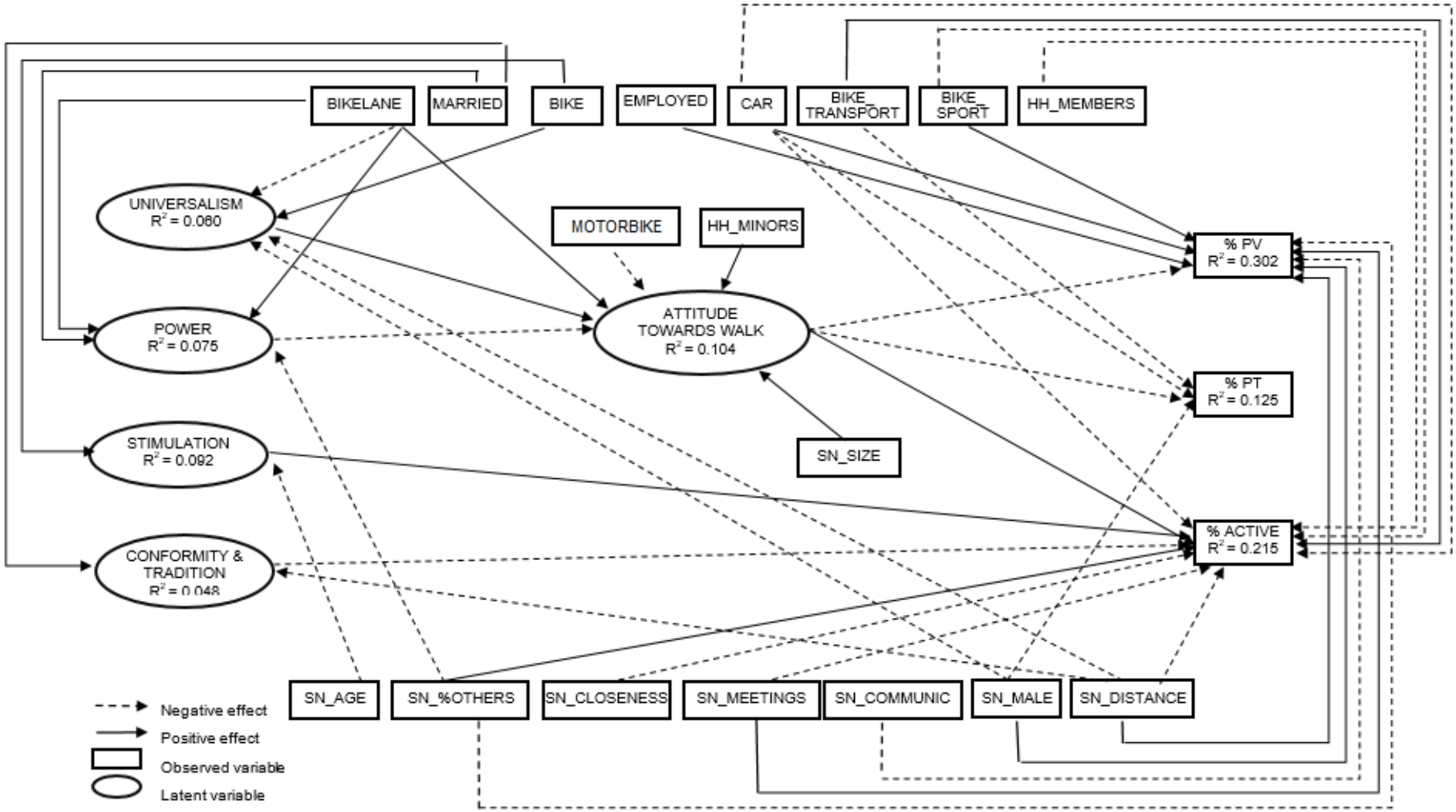

Figure 5. Model 4. Results of SEM model including relations among attitudes towards walking, values, companions, sociodemographic and mode split.

DISCUSSION AND CONCLUSIONS

This paper presents a study of the interrelationships between values, attitudes towards transport modes and companions, considering sociodemographic characteristics. Two Structural Equation Models where fit to test the proposed theoretical framework. The hierarchical value-attitude-behavior structure proposed by Homer and Kahle [12] is confirmed in this study. Additionally, relevant direct relations between values and behavior are obtained, as suggested by several authors (e.g. Kristiansen and Hotte, 1996). The results of the two SEM models support the validity of the proposed theoretical framework and hypotheses. However, not all posited relationships among the variables of the study are significant.

Values and travel behavior

Findings of the models confirm that values influence travel behavior directly without the mediation of attitudes, although not all the posited relations proposed provided significant results, so that Hypothesis 1 is partially confirmed.

Stimulation is related positively with the use of active transport. This result could be explained by the flexibility and freedom that people find walking and cycling, as well as the vision of innovation and challenge caused by the recent growth of cycling lifestyle. Achievement is also associated with active transport use. Traditionally, this value was related to the feeling of ownership of private vehicles. However, Achievement could be no longer related to private modes and its importance could be now associated with active transport due to its relation with health, environment and social influence. The more someone values Achievement, the more importance they confer to social relations, taking care of themselves and being healthy. This innovative aspect might also explain the negative association found between Conformity-Tradition and walking and cycling. People who confer more importance to this value, have a lower use of active modes. Lastly, Security is negatively related with active transport use, which denotes a lack of harmony among the users of the different transport modes.

Our results are in line with those found in the literature. People whose values are included in Openness to Change (Stimulation) and Self-Transcendence (Universalism) quadrants of Schwartz's values, are more inclined towards sustainable travel modes. On the other hand, the more someone values Self-Enhacement (Power, Hedonism) or Conservation (Security, Conformity-Tradition).

Values and attitudes towards transport modes

Several associations between values and attitudes towards transport modes are found in the SEM models, following the framework proposed by Homer and Kahle [12]. However, some personal values (Conformity-Tradition and Achievement) did not provide significant relations with attitudes, thus Hypothesis 2 is partially confirmed.

Firstly, it is found that Stimulation influence attitudes towards cycling positively while Security has a negative impact. On the one hand, the more someone values Stimulation in life, the more positive they feel towards cycling. On the other hand, those who value Security have a negative feeling towards cycling. In Spain and particularly in the main area of the study (Valencia), new bike lanes have been built recently and several campaigns are being carried out to promote the use of bike. This could explain the relation of the bike with innovation or challenge (Stimulation). In this sense, the greater amount of bicycles in the streets and the need for both drivers and pedestrians to live with them, can generate a greater number of tensions among the users of the different transport modes.

Similarly, Power influences attitudes towards walking negatively, which means that people do not associate walking which social status and prestige. Thus, the more someone values Power, the more negative they feel towards walking. Universalism is related positively with attitudes towards walking. Individuals who confer more importance to this value, prioritize understanding, tolerance, and protection for the welfare of all people and for nature and they could see walking as a compatible travel mode with their feelings.

Attitudes towards transport modes and travel behavior

Findings from the SEM models reveal the importance of attitudes towards transport modes on travel behavior. Positive attitudes towards a specific mode influence the use of the mode but also they might influence other modes use. This findings are aligned with the hierarchical structure value-attitude-behavior proposed by Homer and Kahle (1988). Hypothesis 3 is partially confirmed, attitudes towards walking and cycling influence positively the use of active modes and negatively motorized transport: use of private vehicle as expected but also public transport use in the case of attitudes towards walking.

Additionally, it was hypothesized that personal values, sociodemographic variables and attributes of activity-and-trip companions are associated with attitudes towards active modes (Hypothesis 4). Similarly, sociodemographic variables and attributes of activity-and-trip companions are associated with personal values (Hypothesis 5). Most of these posited relations provided relevant results, although not all the variables included were found significant:

Values and companions

The relationship between companions of trips and activities and values is also confirmed. The communication frequency with companions is associated positively with Achievement, which could be due to a more extensive use of ICTs of people who prioritize this value. In particular, individuals who confer more importance to Achievement might use ICTs especially for communication purposes with their social network. Next, having older companions is related negatively with Stimulation, probably explained by the existence of more routine activities in the daily agenda of older people. This fact might cause a negative feeling of innovation, freedom and challenge. Additionally, the percentage of non-family members within companions is positively associated with Power, which suggests that those individuals who meet with a larger number of different people tend to attach more importance to relationships and influence on others.

Values and sociodemographic characteristics

As expected, several sociodemographic characteristics are associated with values. Employed individuals are negatively related to Achievement, which means that these individuals attach less importance to success, innovation or challenge. The fact that they have already an employment might make feel them establish and less willing to change.

Married individuals are associated with Power and Conformity-Tradition. According to this results, marriage could be considered as a symbol of social success, reputation, status and commitment.

Moreover, car availability is negatively related to Achievement. Thus, the more someone values Achievement, the less necessity of owning a car they perceive in terms of innovation or challenge. Considering this result, having a car could be no longer related to personal success. Additionally, bike availability is negatively associated with Power and Security while the existence of bike lanes provided two significant relations: one positive with Power and one

negative with Universalism. This results might reflect a dissonance, while bike lanes contribute to a greater vision of reputation and social status in the area of residence whereas they could be seen as an invasive element of the public space for pedestrians.

Sociodemographic characteristics and attitudes towards transport modes

General sociodemographic characteristics (gender, age, occupation, income, etc) are not significantly associated with attitudes towards transport modes. Only the presence of minors in the household is found positively related with attitudes towards walking. This result could be caused by the situation of dependence generated by children and a larger number of activities carried out close to home (shopping, visiting nearby parks, etc).

Conversely, other interesting relations are found. Car availability is negatively related with attitudes towards cycling while motorbike availability is related also in a negative way with attitudes towards walking. These findings confirm that in general having private modes available influence negatively attitudes towards other transport modes. Lastly, the existence of bike lanes is related to positive attitudes towards walking. It may be interpreted as an improvement of the residential environment.

Trips and activities companions and attitudes towards transport modes

Characteristics of companions did not show significant association with attitudes towards transportation modes. Only the number of companions was found significant and positively associated with attitudes towards walking. The higher amount of companions with whom individuals share their trips and activities, the more opportunities they have to carry out activities close to their residential location. This could be due to the fact that having a large number of different companions facilitates the execution of social activities including those within walkable distances and avoiding the use of motorized transportation.

Trips and activities companions and travel behavior

Having a companion's network composed by a larger number of non-family members is associated with more sustainable mobility. This could be due to the restrictions and dependence derived from family (for instance: children, older people…), which might lead to a biggest use of the car. The influence of gender is also observed, a larger percentage of men among companions is related with the biggest use of the car and less use of PT. In the area of the study, women have a higher use of Public Transport, which implies that those individuals with a more car-oriented mobility (men) influence their companions. Next, a longer distance between companions and the respondent residence involve a higher use of PV at the expense of a lower quota of walking and cycling. Focusing on the frequency of contact, a higher frequency of face-to-face meeting is related to a highest use of PV and less use of active transport. People with more intense social interactions might optimize their time in order to manage a larger number of social activities and tend to use more the car. By contrast, a higher number of remote communications correspond to lower use of PV. This can be explained by the reduction of travel, where on-site meetings are replaced by phone calls, message, emails, etc.

Sociodemographic characteristics and travel behavior

Several associations are also found between sociodemographics and travel behavior. First, students and employed individuals are related to a higher use of PV, which could be also due to the higher availability of private vehicle. Following the same justification, car availability is negatively related with active transport use. Lastly, the purpose of bike use provides also

interesting results. Main use of cycling for transport is associated with higher active transportation and less PT use. On the other hand, cycling for other purposes (sports, relax, etc) implies a higher use of the car and a lower use of active transport modes. This could reveal a different vision of the bike for those who use it mainly for sports purposes who do not consider it as a mode of transport for their daily trips.

Limitations

Limitations of the present study are related to the size and characteristics of the sample. Additional efforts are required to increase the participation of individuals aged over 50 years in web-based surveys.

Practical implications and future research

The relations observed between values and travel behavior provides relevant insights for travel behavior research. Values traditionally associated with private vehicle use, such as Stimulation and Achievement are now related to active transportation use. Moreover, car availability is negatively related to Achievement. Considering these results, owing a car could be no longer related to personal success. This change in the conception of owning a vehicle and sustainable transport should be considered in the formulation of transport policy. For instance, marketing campaigns to promote cycling should focus on challenge and innovation messages instead of power and status concepts.

Attitudes also provided strong associations with travel behavior. For instance, positive attitudes towards active transportation are found to influence positively walking and cycling as expected, but also discourage the use of motorized transport. This relation of complementarity or substitution among transport modes should be taken into account to study intermodal transportation as well and fares definition strategies. Mobility as a Service (MaaS) strategies could also benefit from this results.

New bike infrastructure development and the recent promotion of cycling in the area of the study, Valencia (Spain), might produce certain feeling of invasion of bike lanes for pedestrians, as it was deduced from the relations obtained between values and mode split. This could be also influenced by the recent rise of micro-mobility solutions. The design and planning of this infrastructure should be reconsidered to ensure pedestrian safety. These actions might be complemented with driver's education programs focusing on the coexistence of transportation modes. For this purpose a revision of the mobility regulation in cities should be also addressed.

Additionally, sociodemographic characteristics provide interesting results which could be useful to design specific campaigns for individuals with different value-attitudes orientations to promote sustainable travel. This information could be also valuable to design persuasion strategies to be included in Travel Behavior Change Programs.

Even though only a few relations between companions and values or attitudes are confirmed, strong associations are found with the use of travel modes. Several attributes of companions provide also relevant effects on travel behavior. The presence of minors in the household is linked to a higher dependency of car use. The implementation of flexible and combined transport pass system could encourage the use and sustainable transport modes.

In general, the results of this study provide further evidence to the importance of including psychological factors and social interactions in travel behavior research to promote sustainable mobility.

Future work includes trip-based analysis considering the relationships between companions and respondents of each trip in order to study the differences between the companions

chosen for each episode and their influence on the respondent. Similarly, further research considering the trip purpose is proposed, focusing especially on care mobility related trips and the influence of family members on travel behavior.

AKNOWLEDGEMENTS

This study has been partially funded by the Ministerio de Economía, Industria y Competitividad of Spain, project MINERVA (TRA2015-71184-C2-1-R).

AUTHOR CONTRIBUTION

The authors confirm contribution to the paper as follows: study conception and design: Tomás Ruiz, Lidón Mars; data collection: Tomás Ruiz, Rosa Arroyo and Lidón Mars, analysis and model estimation: Rosa Arroyo; interpretation of results and draft manuscript preparation: Tomás Ruiz, Rosa Arroyo, Lidón Mars, Soora Rasouli and Harry Timmermans. All authors reviewed the results and approved the final version of the manuscript.

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