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Intentions to use bike-sharing for holiday cycling: an application of the Theory of Planned Behavior

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Abstract

This study explored the behavioral factors underlying tourist intentions to use urban bike-sharing for recreational cycling while on holiday. The analytical framework relied on the Theory of Planned Behavior relating tourist intentions to pro-cycling attitudes, interest in bicycle technology, pro-cycling subjective norms and perceived cycling ease. The case-study focused on the new bike-sharing system in Copenhagen (Denmark) and questioned 655 potential tourists about a hypothetical holiday scenario. Structural equation models revealed: (i) the great interest in using bike-sharing, frequently and for multiple purposes; (ii) the relation between holiday cycling and living in a cycling-friendly country, past cycling experience and habitual mode choice; (iii) the appeal of electric bicycles to tourists with high interest in bicycle technology, low perceived cycling ease and weak pro-cycling norms; (iv) the relation between frequent and multi-purpose cycling intentions and stronger pro-cycling attitudes and norms, and greater perceived likelihood that the holiday partners would cycle.

1. Introduction

Bicycle tourism took roots in the late 19th century and remained a marginal niche for over a century until the last decade (Lamont, 2009). Nowadays, cycle holidays are gaining momentum, although they represent around 2-4% of the total holidays (Weston et al., 2012). Nevertheless, current trends in cycling demand and supply indicate a significant market potential for holiday cycling. Unlike cycle holidays where cycling is the main purpose, holiday cycling involves the occasional use of the bicycle as an alternative mode of transportation for exploring a destination (Ritchie, 1998; Downward and Lumsdon, 2001). From the demand perspective, alongside high cycling rates in established cycling countries in Europe (Pucher et al., 2010; Souffriau et al., 2011), the number of recreational cyclists is rapidly growing in car-oriented countries such as the U.S., Canada, and Australia (Moudon et al., 2005; Heesch et al., 2012). From the supply perspective, alongside the on-going development of national and European scenic cycling routes and networks, holiday cycling is widely accessible because many cities are initiating cycling-friendly policies, bike paths, and bike-sharing schemes (e.g., Pucher et al., 2010). Recent estimates of the market share of bicycle tourism in Europe on the basis of cycle holidays and daily cycling excursions revealed that, although

countries with established cycling culture and high cycling rates remain the most appealing, other tourist destinations such as Italy, Spain, Hungary and Poland are observing a rapid increase in cycle tourism (Weston et al., 2012).

The interest in cycle tourism is relatively new and the use patterns of bicycle infrastructure for tourism have been scarcely explored (Deenihan et al., 2013). Most of the existing studies focused on scenic regional, national and European cycling routes and networks. Some studies analyzed the preferences of recreational cyclists for route attributes. Ritchie (1998) showed that cyclists in New Zealand prefer circular scenic routes with high road safety and low traffic congestion. Downward and Lumsdon (2001) found that recreational cyclists in Staffordshire Moorlands seek scenic bike paths that are marked and traffic free, with service and refreshment areas. Chen and Chen (2013) concluded that recreational cyclists in Taiwan prefer bike paths with attractions, refreshment and maintenance areas. Other studies monitored the use patterns of specific bicycle trails. Cope et al. (2003) described the cyclist population using the UK National Cycle Network in terms of socio-economic characteristics, cycling experience and purpose. Lumsdon et al. (2004) revealed that the North Sea cycle route in England is mainly used for short recreational trips and daily excursions. Deenihan et al. (2013) provided details regarding the use of the Great Western Greenway in Ireland by tourists and locals under various weather conditions. Two studies focused on GIS tools for the development of recreational cycling. Souffriau et al. (2011) suggested a path-finding algorithm to help cyclists plan their route in a web-based bicycle route planner for East Flanders in Belgium. Bíl et al. (2012) created a unified GIS database representing the cycle infrastructure in the Czech Republic.

The current study is the first to explore the behavioral factors underlying the intentions to use urban bike-sharing for recreational cycling by potential tourists during their holiday. The case study focuses on the new generation bike-sharing system in Copenhagen (Denmark). The study aims at (i) evaluating the market potential for tourists given an operational and pricing scheme and uncovering the motivators underlying this potential, and (ii) understanding the attractiveness of the design characteristics for tourists and comprehending the bike rental frequency and purpose. The analytical framework is based on the Theory of Planned Behavior (TPB) linking behavioral intentions to attitudes, subjective norms and perceived behavioral control (Ajzen, 1991). Because at the time of this study the bike-sharing system was only at the pilot stage, the data for the analysis derived from a survey among an international sample of 655 adults requested to state their intentions to use the new bike-sharing system during a hypothetical vacation in Copenhagen. The analysis was conducted by means of structural equation modeling (SEM) because of its suitability to encompass joint decisions and to accommodate latent attitudinal factors alongside observed characteristics.

Addressing the factors underlying the intentions to use bike-sharing systems in cities is important from both the tourist and the societal perspective. From the tourist perspective, bike-sharing systems provide the possibility to use a healthy, enjoyable, and relatively inexpensive door-to-door transport mode at the holiday destination. Cycling carries high physical and mental health benefits, even when considering accident and air pollution risks for cycling in urban areas. The benefits are higher in cities with off-road bike paths and when choosing routes with low-traffic volumes (Teschke et al., 2012). From the societal perspective, considerable tourist influx impose a demand pressure on the city public transport and road infrastructure, and generate negative externalities, in particular where the tourism intensity is high and the transport system is not designed to accommodate such influx (Albalate and Bel, 2010). In such cities, understanding the factors shaping tourist demand for bike-sharing systems could alleviate road congestion, public transport overcrowding, air pollution and noise.

Currently there are 375 bike-sharing schemes operating in cities across 33 countries, including iconic cycling cities such as Amsterdam and Copenhagen, and major tourist destinations that are not

naturally associated with cycling such as London, Paris and Barcelona (Parks et al. , 2013). While cycle-hire facilities are less important in rural areas for cycle tourists who usually bring their own bike (e.g., Simonsen et al., 1998; Downward and Lumsdon, 2001), the market potential of such systems among the general tourist population could be higher. A study conducted on the island of Bornholm in Denmark found that 20% of all the tourists hired a bicycle during their stay (Simonsen et al., 1998). While many bike-sharing systems operate in major tourist destinations, studies on their market penetration focused on demand from local residents (Shaheen et al., 2011; Bordagaray et al., 2012; Fishman et al., 2012), and thus their main focus was on the system efficiency for utilitarian trips. Studies on bike-sharing use patterns in such destinations do not differentiate between local residents and tourists (e.g., Kaltenbrunner et al., 2010; Ogilvie and Goodman, 2012; O'Brien et al., 2013). The appeal of the new generation of bicycle-sharing systems for holiday cycling has not been investigated.

The paper is structured as follows. The next section presents the behavioral framework and mathematical modelling approach. Then, the context of the bike-sharing system in Copenhagen as the tourist destination and the survey design are described. Last, results are presented and discussed, and conclusions are drawn.

2. Methodology

2.1 Behavioral framework

The behavioral framework hypothesized in the current study to explain the cycling holiday intentions of potential tourists in an established cycling city is shown in Figure 1.

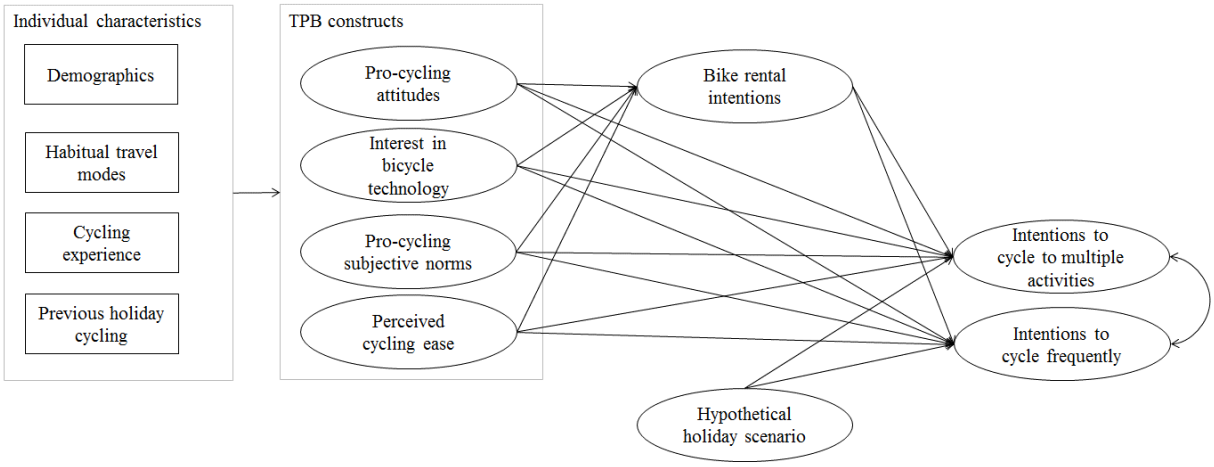

Figure 1 – Behavioral framework

The hypothesized behavioral framework was built upon the TPB latent constructs (Ajzen, 1991) as its core, due to its established behavioral support in a wide variety of behaviors. According to the theory, favorable attitudes and subjective norms and greater perceived behavioral control of conducting the behavior lead to stronger intentions to act. These intentions will eventually transform into observed behavior, provided the availability of resources and the ability to choose one's own behavior.

The investigated attitudes included positive attitudes towards cycling and towards the innovative features of the bicycle sharing system. The positive attitudes towards holiday cycling consisted of interest in experiencing cycling culture, interest in environmentally friendly and physically active holiday, and wish to save time and money. The positive attitudes towards the bike-sharing system included the appeal of the electric bicycles due to their high-tech vibe, speed and ease of riding and interest in using the GPS for navigating.

The subjective norms were related to the country of residence, and comprised subjective norms of cycling and road behavior towards cycling, because the interweave of these norms has a direct impact on cyclists' fear of traffic and self-exclusion from cycling altogether (Chataway et al., 2014). The cycling norms referred to utilitarian and recreational cycling behavior of family, friends and the community, and general positive perception of cycling for recreation. The road behavior norms referred to drivers' general respect for cyclists, norms regarding cyclists prerogative to share the road, drivers' willingness to share the road with cyclists, and general perceptions in the community regarding cycling safety and security.

The perceived behavioral control in the context of transport mode choice intentions can be interpreted as both the amount of choice involved in the action, namely choosing a transport mode on the basis of availability constraints, and the perceived ease of the individual choosing a transport mode due to physical ability and cognitive skills. In the current study, the second interpretation was adopted with respect to cycling as a holiday travel mode. The perceived difficulies associated with holiday cycling were related to cycling and use of the bike-sharing system. The perceived difficulties related to cycling were discomfort due to cycling in hot or rainy weather, physical difficulty in cycling long distances and over the course of several hours, risk of cycling in mixed traffic and across intersections, risk associated with cycling along crowded cycling paths, and unease associated with wearing a helmet while cycling. The perceived difficulties associated with using the bike-sharing system were related to locating the bicycle docking stations, concerns associated with the automatic payment system, difficulty to use the GPS while cycling, security concerns associated with the responsibility for the bicycles, and language barriers.

The TPB constructs were hypothesized to be related to four groups of observed individual characteristics including demographics, habitual travel mode, cycling experience and previous holiday cycling behavior. Positive cycling experience was found in a recent study to play a key role in the formation of future intentions to cycle for utilitarian purposes (Sigurdardottir et al., 2013). In the current study, the roles of habitual mode choice and previous holiday cycling behavior were explored with respect to holiday cycling intentions.

In addition to the TPB latent constructs, the preferred holiday scenario was hypothesized to be related to holiday cycling intentions. A recent study among adolescents in Denmark found that hypothesized visions of the future were related to adolescent intentions to commute by bicycle or by car as adults (Sigurdardottir et al., 2013). Therefore, this study investigated the hypothesis that potential tourists' holiday cycling intentions are related to the vision of their holiday with respect to stay duration, preferred accommodation, propensity to use motorized travel modes during the vacation, travel party size and propensity of the travel partners to cycle.

2.2 Mathematical model

The hypothesized behavioral model structure was investigated by applying structural equation modeling (SEM). This methodology and its application in travel behavior research in the last three decades were reviewed by Golob (2003).

The model in this study contained three sets of equations: measurement equations, structural equations linking the latent attitudinal constructs to individual socioeconomic characteristics, and structural equations relating the latent attitudinal constructs to tourists' holiday cycling intentions in accordance with the path diagram of the hypothesized behavioral model shown in figure 1 and discussed in the previous section. The parameters of the three sets of equations were estimated simultaneously by using Maximum Likelihood with Huber-White covariance adjustment (Yuan and Bentler, 2000). Standard errors were calculated by adopting the White's sandwich-based method that produces robust statistics in the presence of non-normality of indicators and categorical variables (White, 1980). Alongside the traditional descriptive measure of chi-square test of absolute model fit, additional descriptive goodness-of-

fit measures were the standardized root mean residual (SRMR) (Bollen, 1989) and the Root Mean Square of Approximation (RMSEA) (Browne and Cudeck, 1993).

3. Data

3.1 Copenhagen bike-sharing

Copenhagen, the capital city of Denmark, has a vast off-road cycling infrastructure and an established cycling culture and aims towards becoming the "world's best bicycle city" (Gössling, 2013). About 1.2 million kilometers are cycled daily in Copenhagen and the bicycle accounts for 36% of the trips to work and education. Among Copenhageners, 84% have access to a bike, 68% cycle at least once a week, and 30% of the preschool children arrive to school by bike. In a survey conducted by the city of Copenhagen, 67% of the cyclists perceived the city as safe for cycling (Gössling, 2013).

The bicycle infrastructure in Copenhagen consists of roughly 350 kilometers of segregated cycle tracks, 23 kilometers of on-road lanes, and 43 km of off-road green bike paths. A typical Copenhagen-style bike path includes a unidirectional 2.2-2.5 meters wide path, separated from the road and the sidewalk by height and by pavement type. There are nine types of cycling tracks and lanes and eight types of intersection designs suitable for various land uses, street functions, traffic and cyclist volumes (e.g., Nelson, 2007). During 2010, about 20 million Euros were dedicated to improvements in bicycle infrastructure in Copenhagen (City of Copenhagen, 2011). The infrastructure development is accompanied by campaigns such as the "Cycling welcoming campaign" for encouraging new residents to cycle in Copenhagen, "Bike to work" for boosting cycling to work, and "All kids bike" for promoting cycling to school (Cycling Embassy of Denmark, 2012).

Recent cycling policy documents in Copenhagen showed a long-term commitment to maintain the competitive edge of the bicycle through setting ridership goals, planning for bicycles, investing in infrastructure and marketing campaigns, and monitoring programs with emphasis on travel time, safety, security and comfort (City of Copenhagen, 2002, 2012). The plans include improving and extending the bicycle network in terms of connectivity and quality, increasing the number of bicycle parking facilities, developing regional bicycle highways, and improving the integration with public transport. Gössling (2013) provides a detailed review of the policy measures and marketing strategies.

The new generation city and commuter bike-sharing system Gobike replaces the CityBike system that was in operation from 1995 to 2011, and has a special focus on tourists in addition to the residents and commuters. The system will offer 2,000 bicycles in 60 docking racks around the city located in public transport stations, main tourist attractions, cruiseliner docks, and town squares. An electronic lock and tracker will allow leaving the bicycle on the street outside the docking station, and a 24-hour service will assist users. The bicycle will include unisex regular and electric bicycles with a 40 km battery range and a speed restriction for increasing the safety of tourists, the possibility to rent a helmet and a child-seat. A smartphone app will allow locating the nearest bicycle racks, checking bicycle availability, reserving a bike and paying on-line by a subscription, credit card, and travel agency, cruiseliner or hotel vouchers. Tablet computers mounted on the bike and operated in English will serve for booking and paying for the bike and for two options of route planning. The first option will be a route planner showing the route between chosen locations, allowing the user to choose between fast and scenic routes, and recommending coffee shops for a break. The second option will offer three electronically guided tours around the city with explanations of the attractions along the way. The tablet will also provide tips on attractions, train timetables, and will allow buying tickets for public transport. The pilot for the system has been launched in October 2013 and the system is expected to enter in operation during spring 2014.

3.2 Survey design

The data were collected by means of a tailor-made web-based questionnaire. The survey contained three parts.

The first part concerned individual information including age, gender, current country of residence, past 5-year residence or longer in another country, frequency of bicycle, public transport and car use, and questions related to cycling experience both daily and during vacations. The questions concerned cycling experience in years, self-perception as a recreational cyclist, utilitarian cyclist or both, cycling during previous holidays, and cycling during visits in perceived cycling-friendly cities.

The second part concerned engaging in a voluntary future-oriented mental time travel (FMTT) exercise to construct a preferred hypothetical holiday scenario in Copenhagen. The questions concerned the length of stay, accommodation type, accompanying party and the preference for holiday cycling. The importance of the respondents constructing the hypothetical holiday scenario rather than being given a scenario is twofold: firstly, it enables representing tourist holiday preferences heterogeneity; secondly, FMTT is a cognitively demanding task that requires top-down schema-driven construction in order to recombine episodic memories into a representation of the future (Berntsen and Bohn, 2010). The hypothetical vacation scenario construction increases the realism and clarity of the holiday context, thus facilitating the specific task of the hypothetical transport mode choice.

The third part focused on the intentions to use seven transport mode options provided the preferred hypothetical holiday scenario and a short description of the system. The options included the new bike-sharing system and reflected the actual transport mode and pricing options available for tourists in Copenhagen. The questions concerned the likelihood of using each mode rather than the choice between modes since various travel modes can be used during the same vacation. The car options were car rental for one week (280€) or three days (150€). The public transit options were 3-day (25€ per person) and 1-day (10€ per person) city transit pass and a 10-trip transit card (27€ per person). The bike-sharing options comprised a base fee of 10€ per person, an additional fee of 0.55€ per hour per person for a regular bicycle, and 0.80€ per hour per person for an electric bicycle. Two additional questions elicited the cycling frequency and the likelihood of cycling for various activities during the holiday including cultural activities, shopping, sightseeing, wine and dine, and visiting family and friends. The likelihood of choosing each travel mode and cycling to the various activities were measured on a 5-point Likert scale ranging from highly unlikely to highly likely.

The last part of the questionnaire concerned the TBP latent constructs. The attitudes included experiencing the Danish cycling culture, having an environmentally friendly and healthy vacation, having an affordable vacation, and using the electric bicycle and the GPS pathfinder. The subjective norms concerned the country of origin and targeted cycling by friends and family, cycling as a social norm and drivers' attitudes towards sharing the road with cyclists. The perceived behavioral control referred to the perceived ease of cycling and using the bike-sharing system: items related to the perceived cycling ease included weather conditions, cycling time and distance, perceived cycling safety on-road and the possibility of crowded cycle paths; items related to the bike-sharing system included difficulties related to technology (e.g., using the GPS, the tablet computer and smartphone app), difficulty to find the bicycle docks and fear of losing the bike. The TBP items were measured on a 5-point Likert scale ranging from strongly disagree to strongly agree.

3.3 Survey administration

The survey administration to a sample of potential tourists was conducted during November 2013 via on-line social networks of students residing in Copenhagen due to three main reasons. Firstly, visiting friends and relatives (VFR) at the holiday destination is an important motivator in both domestic and

international tourism as a travel purpose and accommodation form (e.g., Backer, 2012), and in particular when students studying abroad are concerned (e.g., Michael et al., 2004). Secondly, social networks are gaining popularity for both branding and promoting urban tourist destinations (Zhou and Wang, 2014), as well as for information search and organization of holiday trips by tourists (Parra-López et al., 2011). Last, social networks offer the possibility to collect a large international sample with relative ease, low cost, high quality and reliability (Efthymiou and Antoniou, 2012). In order to verify the sample reliability, the respondents were offered to participate in a raffle of 10 "I love Copenhagen" T-shirts, as an incentive for providing their contact details at the end of the survey.

Alongside the advantages of social networks as media for data collection among potential tourists, the study is not without limitations. Firstly, the respondents are a non-representative sample of the population and depend on internet accessibility. The distribution of the sample demographics, cycling habits, and cycling experience, suggest that the sample exhibits heterogeneity across population segments, which is in line with the approach taken by Efthymiou and Antoniou (2012) for transport survey administration via social media. Secondly, the holiday scenario refers to an iconic cycling city, well-known for its cycling culture and safe infrastructure, and in which the perceived safety is much higher compared to emerging cycling cities (Chataway et al., 2014). Bearing these limitations in mind, the obtained results are to be viewed as an indicative or diagnostic tool rather than a statistically representative sample of the tourist population, and cannot be generalized to emerging cycling cities where the cycling culture is less visible and the tension between cyclists and motorists is greater.

4. Results

4.1 Sample characteristics and preferred holiday scenario

The survey yielded 801 questionnaies, of which 655 (81.8%) questionnaires were completed without missing data, and thus served for the data analysis and model estimation. The sample size is much larger than Nunnally's (1967) widely applied rule of thumb for SEM analysis, requiring 10 observation for each of the 35 indicators used in this study in setting a lower bound for the sample size adequacy.

The sample consists of completed questionnaires from 35 countries, mainly from Europe but also from other world regions. The sample demographics, habitual travel modes, cycling purpose and experience are portrayed in Table 1. The respondents in the sample are interested in holiday cycling, as 47.8% visited cycling-friendly cities once or twice and 16.5% visit such cities often. Of the respondents who visited cycling-friendly cities, 44.2% visited either Copenhagen or Amsterdam. While on holiday, 32.2% of the respondents rented a bicycle once or twice and 7.0% rented a bicycle often. Only a small percentage brought their own bicycle on vacation: 7.9% once or twice and 3.5% often. Regarding other travel modes while on holiday, only 13.7% often rented a car, while 51.5% never rented a car and 85.6% often used public transport.

In terms of the preferred holiday in Copenhagen, 73.1% prefer to stay approximately one week, 16.0% two weeks and 10.9% longer periods. The most commonly preferred accommodation forms are Bed&Breakfast (33.1%), 3-star hotels (20.5%), family and friends (15.9%), and youth hostels (14.4%). Almost all the respondents prefer to spend their vacation with other people: 54.5% with a friend or a spouse, 12.4% with several family members, and 31.8% with a group of friends. Among the respondents, 28.7% perceive that their accompanying persons are highly likely to cycle, 36.8% that they are likely to cycle, and 19.8% that some of their accompanying persons are likely to cycle while others are not.

Table 1 - Sample characteristics

Variable	Categories	(Percent)			
Gender	Male	Female			
	45.2	54.8			
Age	< 25	25-34	35-44	45-54	55+
	23.5	53.3	12.4	6.4	4.4
Residence in a cycling-friendly country[a]	No	Yes			
	79.7	20.3			
Past long-term residence in a cycling-friendly country[b]	No	Yes			
	93.9	4.1%			
Habitual car use frequency	Daily	2-3 times weekly	Once a week	2-3 times monthly	Rarely
	37.6	16.8	10.5	8.9	26.3
Habitual public transport use frequency	Daily	2-3 times weekly	Once a week	2-3 times monthly	Rarely
	24.1	15.1	7.9	13.1	39.7
Habitual bicycle use frequency	Daily	2-3 times weekly	Once a week	2-3 times monthly	Rarely
	20.8	12.4	6.0	9.0	51.9
Habitual cycling purpose	Non-cyclist	Recreation	Utilitarian	Both	
	17.1	28.1	25.2	29.6	
Cycling experience	Non-cyclist	< 1 year	2-3 years	3-4 years	> 5 years
	17.1	5.3	4.9	4.1	68.5

Notes: [a] According to the ranking of the European Cyclist Federation (i.e., Denmark, Netherlands, Sweden, Finland, Germany, Belgium, Austria, Hungary, Slovakia and the United Kingdom) in addition to Switzerland, China, Japan, India and India; [b] five years or more are considered as a long-term residence

4.2 Attitudes, norms and difficulties associated with cycling

The attitudes, subjective norms and perceived behavioral control related to holiday cycling were obtained by means of exploratory factor analysis. Tests of internal consistency and sample adequacy constituted the necessary preliminary conditions for obtaining meaningful factors. The Spearman correlation matrix among the indicators provided the input for both the tests and the factor analysis. The items obtained in the survey show good internal consistency (Cronbach's alpha = 0.709) and good sampling adequacy according to Kaiser-Meyer-Olkin (KMO) measure, both at the overall (KMO = 0.797), and at the single item level (KMO = 0.538 - 0.906). The Spearman correlations matrix contained correlations with absolute value between 0.3-0.7, and the value of its determinant was $2.4E^{-5}$, establishing correlations without multi-collinearity. The result of the Bartlett's sphericity test rejected the null hypothesis of an identity correlation matrix (p = 0.000).

Exploratory principal axis factor analysis with subsequent orthogonal rotation (Varimax rotation with Kaiser normalization) produced four factors according to the scree-plot analysis. The factor loadings are presented in table 2 where, in order to facilitate factor labeling, the dominant items marked in bold were defined as those with an absolute value of the loading greater than 0.35. The first factor (F1) was named "pro-cycling attitudes" and related to health, environment and convenience. The second factor (F2) was identified as "interest in bicycle technology". The third factor (F3) was labeled "pro-cycling subjective norms" and referred to cycling norms and respect for cyclists. The last factor (F4) was defined "perceived cycling ease" and concerned weather, distance, traffic, crowding on cycling path, use of GPS while cycling and use of the automatic payment system.

Table 2 - Factor loading

Item	Description	F1	F2	F3	F4
DanCyc	I will be interested to experience the Danish cycling culture	**0.592**	0.167	-0.098	0.178
Envhol	I will be interested in having an environmentally-friendly vacation	**0.607**	0.062	-0.133	0.073
Acthol	I will be interested in staying physically active during my vacation	**0.591**	-0.031	-0.005	0.047
Savmon	I prefer cycling in order to save travel money during my vacation	**0.592**	0.100	0.000	-0.048
Cycnowt	I prefer cycling over parking search or waiting for public transport	**0.656**	0.180	0.020	0.090
Cycconv	I prefer cycling because it is very convenient for short distances	**0.663**	0.164	0.083	0.123
Ebtech	I will be interested to ride high-tech electric bicycle	0.222	**0.751**	-0.158	0.017
Ebfast	I will be interested to ride electric bicycle because they are fast and easy	0.222	**0.759**	-0.119	-0.114
Ebgps	I will be interested to try the bike-sharing system because of the GPS	0.297	**0.537**	-0.011	0.082
Cycfam	Many of my family and friends cycle	0.085	0.004	**0.606**	0.003
Cycpop	People usually cycle in the city	-0.044	0.032	**0.722**	-0.067
Cycrec	People usually cycle for receation	0.020	0.189	**0.265**	0.067
Cycrec	People think that cycling for recreation is cool	0.048	0.095	**0.439**	0.098
Cycngt	People feel safe to cycle alone at night	-0.051	-0.117	**0.755**	0.011
Cycsaf	It is common that bicycles on the street could be stolen (R)	-0.072	-0.076	0.110	0.022
Cycroad	Drivers think that roads are only for cars (R)	-0.135	-0.059	**0.603**	-0.083
Cychelm	Cyclists generally wear helmets	0.069	-0.093	0.157	0.028
Cycmxtr	Cyclists generally are not afraid to cycle on the road	-0.064	-0.054	**0.492**	-0.033
Cycchild	Cycling is not safe for children (R)	-0.061	-0.096	**0.593**	-0.024
Cycpark	Cyclists are expected to cycle only in parks or off-road cycling paths	0.046	0.138	**-0.561**	0.002
Cycresp	Drivers generally do not respect cyclist (R)	-0.125	-0.133	**0.675**	-0.039
Cycweat	I do not like to cycle in the rain or in a hot day (R)	0.298	-0.301	0.240	**0.386**
Cyclong	I do not like to cycle long distances (R)	**0.432**	-0.304	0.176	**0.465**
Nohelm	Cycling with a helmet is not cool (R)	0.165	-0.014	-0.173	0.226
Cyctime	I am sure cycling many hours is easy	0.324	-0.133	0.132	0.308
Cycint	I will not feel safe cycling through cross-roads with much traffic (R)	0.062	-0.044	0.129	**0.604**
Cycpath	I will feel comfortable cycling on off-road bike paths	0.175	0.027	-0.036	-0.019
Cyclight	I will feel safe following the special traffic lights for bicycles	0.260	0.108	-0.058	0.125
Cycbump	I will be afraid to bump into cyclists in a crowded cycling path (R)	-0.003	0.044	-0.038	**0.436**
Cycgps	It will be difficult to look at the GPS while cycling (R)	0.069	0.140	0.010	**0.508**
Tabeng	It would be easy to use the Tablet in English	0.045	-0.129	0.220	0.214
Cycpay	I do not like to pay by credit card via the automatic system (R)	0.003	-0.013	-0.059	**0.348**
Findock	Finding an available bicycle dock will be easy	0.141	0.123	-0.152	0.233
Cycsec	I am afraid to leave the bike because it can be stolen or forgotten (R)	0.005	-0.035	0.047	**0.445**
Appfind	Using a phone app to find the nearby bicycle dock	0.182	0.198	-0.082	0.208

Notes: Reversed items are marked with (R)

4.3 Cycling intentions while on holiday in Copenhagen

The respondents in the survey showed interest in using the bike-sharing system, cycling frequently and cycling for multiple activity purposes. Most respondents (74.3%) expressed that they are likely or highly likely to use the bike-sharing system while on vacation. Among the respondents willing to rent a bicycle, the

majority (60.5%) does not have a preference between regular and electric bicycles, 31.3% has a clear preference for renting a regular bicycle, and only 8.2% has a clear preference for an electric bicycle. Among the respondents, 48.4% intend to cycle daily, while 36.5% intend to cycle 2-3 times a week and 15.1% intend to cycle once a week or less. Regarding holiday cycling purposes, most respondents are likely or highly likely to cycle in natural areas and parks (89.5%), around the city (86.0%), and with friends and family (80.2%). The least popular cycling purposes are cycling for shopping activities (45.2%) and in the evenings to bars and pubs (46.1%). Most respondents (82.3%) view themselves as cycling for at least four activity purposes.

The Shapiro-Wilk normality test (Shapiro and Wilk, 1965), reported in the appendix, rejected the null hypothesis that the sample comes from a normal distribution, and therefore the model parameters were estimated simultaneously by using Maximum Likelihood with Huber-White covariance adjustment (Yuan and Bentler, 2000). Standard errors were calculated by adopting the White's sandwich-based method that produces robust statistics in the presence of non-normality of indicators and categorical variables (White, 1980).

Tables 3 through 7 present the model parameter estimates and their critical ratios (C.R). Table 3 presents the measurement equations. Table 4 shows the structural equations linking the latent TPB constructs tourists characteristics. Table 5 illustrates the structural equations linking the intentions to rent different types of bicycle (i.e., regular, electric, regular/electric, neither) to the TPB constructs. Table 6 shows the structural equations relating the cycling frequency and multi-purpose cycling intentions to the TPB constructs, preferred bicycle type, and relevant holiday scenario characteristics. Table 7 presents the estimated covariance matrix for the latent variables.

Goodness-of-fit indices reveal that the model fits well, as the ratio between chi-square and degrees of freedom is 2.67 (chi-square = 2957.476, df = 1105) which is well below the maximum acceptable value recommended by Ullman (1996). In addition, the RMSEA is equal to 0.051 and the SRMR is equal to 0.064, which are well below the maximum accepted values of 0.08 and 0.10 (Vandenberg and Lance, 2000). The Construct Reliabilities were calculated for each construct and varied between 0.89 and 0.93, and the Average Variance Explained was 0.58, which shows convergent validity in that the variance due to measurement error is less than the variance due to the latent factors.

The TPB constructs are related to the respondents' demographics, habitual mode choice and holiday cycling experience.

Pro-cycling attitudes are stronger (at the 0.05 significance level) for respondents who (i) are female, (ii) reside in a non-cycling-friendly country, (iii) cycle daily, (iv) are both recreational and utilitarian cyclists, and (v) often rent bicycles on holidays. At a lower significance level, pro-cycling attitudes are linked positively to frequent holidays in cycling-friendly cities and negatively to habitual weekly transit use.

Interest in bicycle technology is related (at the 0.05 significance level) to habitual daily car use and rarely or never spending holidays in cycling-friendly cities. At a lower significance level, it is associated negatively with current or past residence in a cycling-friendly country and positively with frequent bike rental on holidays.

Positive subjective norms towards cycling are stronger (at the 0.05 significance level) for respondents who (i) currently reside in cycling-friendly countries, (ii) cycle daily, (iii) are both recreational and utilitarian cyclists. Habitual cycling with lower frequency is also positively associated with positive subjective norms towards cycling, but at a lower significance level.

Perceived cycling ease is positively related (at the 0.05 significance level) to (i) male respondents, (ii) habitual daily cyclists, (iii) experienced cyclists, and (iv) rarely renting bicycles on holiday, and is negatively related (at the 0.05 significance level) to frequent daily or weekly car and transit use. At the 0.10

significance level it is related positively to cycling for both recreational and utilitarian purposes and negatively to living in a cycling-friendly country.

Table 3 - Estimates of the measurement equations

Pro-cycling attitudes (F1)		
Variable	Est.	C.R.
DanCyc	1.000	--
Envhol	1.009	17.45
Acthol	0.881	16.03
Savmon	1.014	17.59
Cycnowt	1.233	21.03
Cycconv	1.194	20.77
Cyclong	0.409	6.86

Interest in bicycle technology (F2)		
Variable	Est.	C.R.
Ebtech	1.000	--
Ebfast	0.999	26.29
Ebgps	0.696	21.82

Pro-cycling subjective norms (F3)		
Variable	Est.	C.R.
Cycfam	1.000	--
Cycpop	1.205	19.89
Cycrec	0.618	11.27
Cycrec	0.690	12.29
Cycngt	1.120	18.21
Cycroad	1.158	17.66
Cycmxtr	0.762	13.18
Cycchild	0.958	16.11
Cycpark	-0.872	-13.88
Cycresp	1.181	18.89

Perceived cycling ease (F4)		
Variable	Est.	C.R.
Cycweat	1.000	--
Cyclong	1.093	12.77
Cycint	0.923	12.62
Cycbump	0.618	9.00
Cycgps	0.700	9.99
Cycpay	0.507	7.61
Cycsec	0.706	10.16

Preferences towards bicycle types for cycling while on holiday are related to the TPB constructs. A clear preference towards renting a regular bicycle is positively related (at the 0.05 significance level) to higher perceived cycling ease and lower interest in bicycle technology, while at a lower significance level it is also positively associated with having stronger pro-cycling subjective norms. A clear preference towards an electric bicycle is related (at the 0.05 significance level) to greater interest in bicycle technology, lower perception of cycling ease, and weaker subjective norms towards cycling. At the 0.10 significance level, it is also positively related to pro-cycling attitudes. Intentions to rent either a regular or an electric bicycle are positively related (at the 0.05 significance level) to pro-cycling attitudes, interest in bicycle technology and higher perceived cycling ease. At the 0.10 significance level, they are related to weaker pro-cycling subjective norms. Respondents who intend to avoid cycling during their holiday have lower pro-cycling attitudes, lower interest in bicycle technology, higher perceived difficulty of cycling, and stronger subjective norms towards cycling.

Intentions to cycle more frequently are positively related (at the 0.05 significance level) to (i) stronger pro-cycling attitudes, pro-cycling subjective norms and perceived cycling ease, (ii) a clear preference for renting regular bicycles, and (iii) a greater perceived likelihood that the holiday travel partners would cycle, and negatively to a clear pereference for electric bicycles. At a lower significance

level, holiday cycling frequency is related positively to the interest in bicycle technology and negatively related to the perceived intentions to use motorized modes (i.e., car or public transport) during the hypothetical holiday scenario.

Table 4 - Estimates of the structural equations explaining the TPB constructs

Pro-cycling attitudes (F1)		
Variable	Est.	C.R.
Cycling-friendly country	-0.392	-4.78
Male	-0.188	-3.09
Cycling daily	0.420	3.64
Transit use 2-3 times weekly	-0.122	-1.42
Bike rent often on holiday	0.539	4.36
Recreation & utility cyclist	0.196	2.13
Often visit cycling cities	-0.136	-1.61

Interest in bicycle technology (F2)		
Variable	Est.	C.R.
Cycling-friendly country	-0.169	-1.57
Past cycling country	-0.398	-1.59
Using car daily	0.299	2.68
Rarely visit cycling cities	0.213	1.80
Never visit cycling cities	0.298	2.30
Bike rent often on holiday	0.257	1.37

Pro-cycling subjective norms (F3)		
Variable	Est.	C.R.
Cycling-friendly country	0.658	7.99
Cycling 2-3 times monthly	0.168	1.86
Cycling 2-3 times weekly	0.133	1.37
Cycling daily	0.413	4.05
Recreation & utility cyclist	0.230	2.83
Utilitarian cyclist	0.094	1.25

Perceived cycling ease (F4)		
Variable	Est.	C.R.
Cycling-friendly country	-0.146	-1.75
Male	0.275	4.33
Cycling daily	0.301	2.62
Transit use 2-3 times weekly	-0.237	-2.77
Transit use daily	-0.186	-2.25
Car use 2-3 times weekly	-0.222	-2.46
Car use daily	-0.254	-2.86
Bike rent rarely on holiday	0.173	2.46
Recreation & utility cyclist	0.163	1.79
5-year cycling experience	0.309	4.72

Table 5 - Estimates of the structural equations explaining bicycle type rental intentions

	Only regular bicycle (ORB)		Only electric bicycle (OEB)		Regular or electric bicycle (REB)		No bike rental (NOB)	
Variable	Est.	C.R.	Est.	C.R.	Est.	C.R.	Est.	C.R.
Pro-cycling attitudes	-0.045	-0.57	0.148	1.67	0.534	7.59	-0.736	-9.29
Interest in Bicycle technology	-0.620	-12.35	0.400	5.89	0.661	14.56	-0.456	-8.13
Pro-cycling subjective norms	0.144	1.57	-0.357	-2.87	-0.149	-1.84	0.211	2.28
Perceived cycling ease	0.241	2.63	-0.213	-2.03	0.349	4.11	-0.647	-6.95

Intentions to cycle for multiple purposes are positively associated (at the 0.05 significance level) with (i) stronger pro-cycling attitudes, interest in bicycle technology, and perceived cycling ease, (ii) clear preference towards regular bicycles, and (iii) a greater perceived likelihood that the holiday travel partners would cycle. At a lower significance level, they are negatively related to the preference to rent either a regular bicycle or an electric bicycle without a clear preference between the two options. The intentions to

cycle for multiple purpose and intentions to cycle frequently during the holiday are weakly but significantly positively correlated.

Table 6 - Estimates of the structural equations explaining cycling frequency and purpose intentions

Holiday cycling frequency (CFR)			Multi-purpose holiday cycling (CMP)		
Variable	Est.	C.R.	Variable	Est.	C.R.
Pro-cycling attitudes	0.405	3.79	Pro-cycling attitudes	0.847	6.11
Interest in Bicycle technology	0.187	1.59	Interest in Bicycle technology	0.644	3.88
Pro-cycling subjective norms	-0.166	-2.07	Pro-cycling subjective norms	-0.010	-0.08
Perceived cycling ease	0.280	2.89	Perceived cycling ease	0.295	2.33
Only regular bicycle	0.137	2.09	Only regular bicycle	0.227	2.66
Only electric bicycle	-0.162	-2.41	Only electric bicycle	-0.002	-0.02
Regular or electric bicycle	0.026	0.46	Regular or electric bicycle	-0.126	-1.68
No bike rental	-0.076	-1.28	No bike rental	0.046	0.61
Likely/highly likely car rental	-0.220	-1.39	Partners likely to cycle	0.577	3.94
Likely/highly likely transit use	-0.143	-1.46	Partners highly likely to cycle	0.966	4.72
Partners likely to cycle	0.269	2.43			
Partners highly likely to cycle	0.632	4.81			
Correlation between holiday cycling frequency and multi-purpose cycling				0.243	3.62

Table 7 - Estimated covariance matrix for the latent variables

	F1	F2	F3	F4	CFR	CMP	ORB	OEB	BREB	NOB
F1	0.495									
F2	0.005	0.826								
F3	0.010	-0.058	0.541							
F4	0.032	-0.025	0.080	0.482						
CFR	0.249	0.069	-0.017	0.216	1.141					
CMP	0.396	0.321	0.048	0.168	0.648	1.260				
ORB	-0.016	-0.527	0.133	0.141	0.132	0.058	1.055			
OEB	0.064	0.357	-0.232	-0.137	-0.138	0.132	-0.290	1.069		
BREB	0.277	0.549	-0.086	0.157	0.283	0.350	-0.327	0.257	1.070	
NOB	-0.385	-0.377	0.081	-0.308	-0.434	-0.491	0.189	-0.171	-0.570	1.119

5. Discussion and conclusions

The current study is the first to explore the motivating behavioral factors for the intentions to use the new generation urban bike-sharing in Copenhagen for cycling by potential tourists during a hypothetical holiday scenario.

The results shed light on the TPB constructs associated with behavioral intentions for holiday cycling. Pro-cycling attitudes are related to being physically active while on holiday, having an environmentally friendly vacation, and having greater convenience in saving money and time, in particular for short distances. The interest in bicycle technology is related to using the GPS system, the possibility for higher speed and easier ride, and the high-tech vibe of the electric bicycle. Pro-cycling subjective norms

refer to norms of cycling among family and friends and in the community in general, perception of cycling as a cool activity, drivers' respect for cyclists and greater feeling of cyclist inclusion and safety. Perceived cycling ease is associated with concerns about the weather, distance, traffic, crowding on cycling path, the use of GPS while cycling, and the automatic payment system.

The TPB constructs are significantly related to the place of residence in a cycling-friendly country, habitual mode choice and past experience and interest in cycle tourism. People residing in cycling-friendly countries exhibiting at the same time higher subjective norms and lower enthusiasm towards cycling. Possibly, they are less enthusiastic about cycling because they cycle from early childhood and perceive it as a natural and integral part of their daily life. Frequent and multi-purpose bicycle use are positively related to positive attitudes, subjective norms and ease of cycling. Frequent car and public transport use are mainly related to a greater perceived cycling difficulty, and greater car use is positively associated with higher interest in bicycle. Regarding cycle tourism, the TPB constructs are mainly associated with bringing one's own bike and frequent bike rental at the destination, but also visiting cycling-friendly cities.

The results show that there is much interest from potential tourists in using the bike-sharing system, cycling frequently and cycling for multiple activity purposes.

Most respondents intend to use the bike-sharing system while on vacation and have no preference for electric or regular bicycles. Only 8.2% of the potential tourists prefer electric bicycles. Weston et al. (2012) report that in a study among German tourists, 4% were currently using electric bicycle while 15% stated that they could imagine doing so in the future. The results of this study predict a lower market share for electric bicycles in urban areas. Possibly, reasons for the lower estimate in this study could be the sample composition of international tourists, and the emphasis on a realistic well-defined hypothetical vacation scenario and pricing options instead of an undefined future. The preferences towards bicycle types for cycling while on holiday are related to the TPB constructs. Motivating factors for preferring regular bicycles are higher perceived cycling ease, stronger pro-cycling subjective norms, and lower interest in bicycle technology. Motivating factors for a clear preference towards electric bicycle are pro-cycling attitudes, greater interest in bicycle technology, lower perceived cycling ease, and weaker pro-cycling subjective norms.

Among the respondents, 48.4% intend to cycle daily and only 15.1% intend to cycle once a week or less. Most respondents (82.3%) view themselves as cycling for at least four activity purposes. The most popular cycling activities imagined by more than 80% of the respondents are cycling in natural areas and parks, cycling around the city and cycling with friends and family. The least popular activities are cycling for shopping and cycling in the evening to bars and pubs. Possible reasons could be that these activities are less popular as holiday activities in the sample, and that they are viewed as less suitable for cycling because of the need to carry bags and the perceived safety and security involved with cycling at night or while under the influence of alcohol.

Intentions to cycle frequently and for multiple purposes during the holiday are linked to stronger pro-cycling attitudes, pro-cycling subjective norms and perceived cycling ease, and the transportation aspects of the holiday. Specifically, higher holiday cycling frequency is negatively related to the propensity to rent a car or use public transport, and positively related to a clear preference for renting regular bicycles, and greater perceived likelihood that the holiday travel partners would cycle. Similarly, cycling for multiple purposes is positively related to stronger pro-cycling attitudes, interest in bicycle technology, perceived cycling ease, a clear preference towards regular bicycle, and a greater perceived likelihood that the holiday travel partners would cycle. Hence, holiday travel mode choice can be viewed as a joint group decision rather than individual ones, which is of high importance because only a marginal share (1.8%) of the

respondents intend to spend their holiday alone, and the third most popular cycling activity is cycling with friends and family.

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Appendix

The attitudinal item statistics, comprising means, standard deviation, skew, kurtosis and Shapiro-Wilk normality test results are provided in table A1.

Table A1 - Attitudinal item statistics

Description	Mean	St.Dev	Skew	Kurtosis	Shapiro-Wilk statistic[a]
I will be interested to experience the Danish cycling culture	4.16	0.87	-1.16	1.67	0.796
I will be interested in having an environmentally-friendly vacation	4.03	0.85	-0.83	0.79	0.831
I will be interested in staying physically active during my vacation	3.89	0.95	-0.69	0.31	0.857
I prefer cycling in order to save travel money during my vacation	3.81	1.01	-0.63	-0.13	0.870
I prefer cycling over parking search or waiting for public transport	4.14	0.91	-1.11	1.15	0.803
I prefer cycling because it is very convenient for short distances	4.25	0.81	-1.08	1.29	0.786
I will be interested to ride high-tech electric bicycle	3.78	1.08	-0.77	0.02	0.863
I will be interested to ride electric bicycle because they are fast and easy	3.47	1.12	-0.43	-0.53	0.899
I will be interested to try the bike-sharing system because of the GPS	3.58	1.05	-0.64	0.12	0.879
Many of my family and friends cycle	3.08	1.23	-0.08	-1.04	0.908
People usually cycle in the city	2.92	1.23	0.15	-1.07	0.902
People usually cycle for receation	3.59	0.91	-0.62	0.13	0.861
People think that cycling for recreation is cool	3.16	1.00	-0.20	-0.46	0.906
People feel safe to cycle alone at night	2.27	1.17	0.74	-0.39	0.855
It is common that bicycles on the street could be stolen (R)	2.09	1.05	0.96	0.40	0.835
Drivers think that roads are only for cars (R)	2.09	1.18	0.96	-0.10	0.812
Cyclists generally wear helmets	2.42	1.16	0.47	-0.78	0.881
Cyclists generally are not afraid to cycle on the road	2.78	1.15	0.13	-0.96	0.905
Cycling is not safe for children (R)	2.49	1.20	0.48	-0.75	0.887
Cyclists are expected to cycle only in parks or off-road cycling paths	3.08	1.23	-0.16	-1.06	0.902
Drivers generally do not respect cyclist (R)	2.30	1.19	0.79	-0.29	0.851
I do not like to cycle in the rain or in a hot day (R)	2.28	1.08	0.74	-0.16	0.860
I do not like to cycle long distances (R)	2.81	1.17	0.14	-1.00	0.902
Cycling with a helmet is not cool (R)	3.36	1.16	-0.34	-0.68	0.906
I am sure cycling many hours is easy	2.96	1.09	0.11	-0.93	0.899
I will not feel safe cycling through cross-roads with much traffic (R)	2.96	1.13	0.01	-0.94	0.908
I will feel comfortable cycling on off-road bike paths	3.99	0.86	-0.86	0.77	0.829
I will feel safe following the special traffic lights for bicycles	4.19	0.69	-0.72	1.12	0.781
I will be afraid to bump into cyclists in a crowded cycling path (R)	3.41	1.11	-0.30	-0.71	0.904
It will be difficult to look at the GPS while cycling (R)	3.29	1.02	-0.17	-0.72	0.900

It would be easy to use the Tablet in English	3.40	1.10	-0.40	-0.64	0.897
I do not like to pay by credit card via the automatic system (R)	3.46	1.07	-0.59	-0.29	0.882
Finding an available bicycle dock will be easy	3.46	0.83	-0.24	0.19	0.870
I am afraid to leave the bike because it can be stolen or forgotten (R)	2.92	1.04	0.08	-0.88	0.895
Using a phone app to find the nearby bicycle dock	3.72	0.92	-0.58	0.20	0.871

Note: [a] The Shapiro-Wilk test statistic is significantly different than unity at the 0.01 significance level for all the items