Applying the Theory of Planned Behavior to Understand the Intentions to Use Bike-Sharing for Holiday Cycling

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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.

INTRODUCTION

Bicycle tourism originated in the late 19th century, remained a marginal niche for over a century, and gained momentum in the last decade, although still represents only about 2-4% of the total holidays (*1*). Current trends in cycling demand and supply indicate a significant market potential for holiday cycling: from the demand perspective, high cycling rates exist in established cycling countries in Europe (*2*, *3*), and the number of recreational cyclists is rapidly growing in car-oriented countries such as the U.S., Canada, and Australia (*4*, *5*); from the supply perspective, national and European scenic cycling routes and networks are rapidly developing, and holiday cycling is widely accessible because many cities are initiating cycling-friendly policies, bike paths, and bike-sharing schemes (*2*). Recent estimates of bicycle tourism market shares in Europe 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 (*1*).

The interest in cycle tourism is relatively new and the use patterns of bicycle infrastructure for tourism have been scarcely explored (*6*). Most studies focused on scenic cycling routes and networks. Studies analyzing preferences for route attributes showed that cyclists in New Zealand prefer circular scenic routes with high road safety and low traffic congestion (*7*), recreational cyclists in Staffordshire Moorlands seek scenic bike paths that are marked and offer refreshment areas (*8*), and recreational cyclists in Taiwan prefer bike paths with attractions, refreshment and maintenance areas (*9*). Studies monitoring use patterns of bicycle trails revealed that cyclists using the UK National Cycle Network are very heterogeneous from a socio-economic and an experience perspective (*10*), the North Sea cycle route in England is mainly used for short recreational trips and daily excursions (*11*), and the use of the Great Western Greenway in Ireland by tourists and locals differs under various weather conditions (*6*). Two additional studies focused on GIS tools for the development of recreational cycling, namely to help cyclists plan their route in a web-based bicycle route planner for East Flanders in Belgium (*3*) and to create a unified GIS database representing the cycle infrastructure in the Czech Republic (*12*).

This 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, which is highly important because domestic and international tourists form a large demand group for bike-sharing, in particular in major tourist destinations (*13*). Addressing the factors underlying the intentions to use bike-sharing systems in cities is important from both the tourism and the transport planning perspectives. From the tourism perspective, bike-sharing systems provide the possibility to use a healthy, enjoyable, and relatively inexpensive door-to-door transport mode at the holiday destination (*14*). From the transport planning perspective, considerable tourist influx imposes a demand pressure on the city public transport and road infrastructure and might generate negative externalities (*15*). As bike-sharing systems can be a complement or a substitute of public transport, they can be a sustainable solution and contribute to protect scenic, sport, and historical conservation areas (*13*). Hence, it is important to understand the factors shaping tourist demand for bike-sharing systems in order to help in their design and branding to tourists.

The number of bike-sharing systems worldwide nears 700 systems operating in iconic cycling cities and major tourist destinations (*16*). Bike-sharing systems allow users to access bicycles located in bicycle docks around the city on an as-needed basis, and while they are less important in rural areas for tourists bringing their own bike (*8*), their market potential

among the general tourist population is high. While many bike-sharing systems operate in major tourist destinations, studies on their market penetration focus on demand from local residents (*17, 18*), and thus they look at 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., *19, 20, 21*). The appeal of the new generation of bike-sharing systems for holiday cycling has not been investigated so far, and this study is the first looking into this research direction.

The case-study focuses on the new generation bike-sharing system in Copenhagen and 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 (*22*). 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.

The paper is structured as follows. The next section presents the background of the case-study. The following 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.

METHODOLOGY

Behavioral framework

Figure 1 shows the hypothesized behavioral framework to explain the cycling holiday intentions of potential tourists in an established cycling city.

The behavioral framework was built upon the TPB (*22*), due to its established behavioral support in a wide variety of behaviors. According to this theory, favorable attitudes, subjective norms and greater perceived behavioral control of conducting the behavior lead to stronger intentions to act. These intentions eventually transform into actual 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 bike-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 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 (*23*). The cycling norms referred to utilitarian and recreational cycling behavior of family, friends and community, and general positive perception of recreational cycling. The road behavior norms referred to drivers' general respect for cyclists, 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 this study, the second interpretation was adopted with respect to cycling as a holiday travel mode. The perceived difficulties associated with holiday cycling were linked 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 hours, risk of cycling in mixed traffic and across intersections, risk of cycling along crowded cycling paths, and unease associated with wearing a helmet. The perceived difficulties associated with using the bike-sharing system were related to locating the bicycle docking stations, using the automatic payment system, using the GPS while cycling, feeling responsible for the bicycles, and overcoming language barriers.

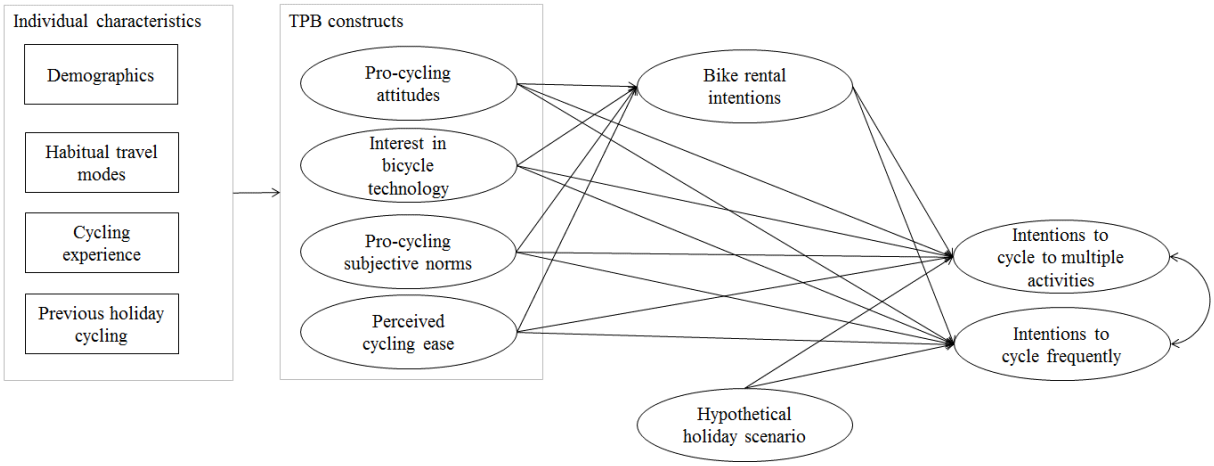

FIGURE 1 Behavioral framework.

The TPB constructs were hypothesized to be related to four groups of observed individual characteristics: 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 (*24*). In this 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 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 (*24*). 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.

Mathematical model

The hypothesized behavioral model structure was investigated by applying SEM (*25*).

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 (*26*). 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 (*26*). 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) and the Root Mean Square of Approximation (RMSEA).

DATA

Copenhagen bike-sharing

Copenhagen has a vast off-road cycling infrastructure where about 1.2 million kilometers are cycled daily and 36% of the trips to work and education are by bicylce. The bicycle infrastructure consists of roughly 350 kilometers of segregated cycle tracks, 23 kilometers of on-road lanes, and 43 km of off-road green bike paths. Efforts are made not only in infrastructure development, but also in promoting campaings, 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 (for details, see *27*).

The new generation bike-sharing system Gobike replaces the CityBike system that was in operation from 1995 to 2011, and focuses 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 stations, and a 24-hour service will assist users. The bicycles will include unisex regular and electric bicycles with a 40 km battery range, a speed restriction for increasing the safety of tourists, and 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 subscription, credit card, cruiseliner or hotel vouchers. Tablet computers mounted on the bike and operated in English will serve for booking and paying 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 train timetables and will allow buying tickets for public transport. The pilot for the system has been launched in late 2013 and the system is expected to enter in operation during summer 2014.

Survey design and administration

Data were collected by means of a tailor-made web-based questionnaire consisting of four parts.

The first part concerned individual information about age, gender, current country of residence, past 5-year residence or longer in another country, frequency of bicycle, public

transport, and car use. Additional questions investigated 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, FMTT enables representing tourists' holiday preference 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 (*28*). The hypothetical holiday scenario construction increases the realism and clarity of the holiday context, thus facilitating the task of the hypothetical transport mode choice.

The third part concerned the intentions to use seven transport mode options given the preferred hypothetical holiday scenario. The options included the new bike-sharing system, reflected the actual transport mode and pricing options available for tourists in Copenhagen, and elicited the likelihood of using each mode rather than the choice between modes since different modes can be used during the same vacation. The options were: car rental for one week (280€), car rental for three days (150€), 3-day transit pass (25€ per person), 1-day transit pass (10€ per person), 10-trip transit card (27€ per person), subscription to bike-sharing with regular bicycle (10€ per person plus 0.55€ per hour per person), and subscription to bike-sharing with electric bicycle (10€ per person plus 0.80€ per hour per person). 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 concerned the TPB 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 (weather conditions, cycling time and distance, perceived cycling safety on-road, possibility of crowded cycle paths) and difficulties in using the bike-sharing system (using the GPS and the tablet, finding the bicycle docks and fearing to lose the bicycle). The TPB items were measured on a 5-point Likert scale ranging from "strongly disagree" to "strongly agree".

The survey was administered to a sample of potential tourists during November 2013 via on-line social networks of students residing in Copenhagen due to three main reasons. Firstly, visiting friends and relatives at the holiday destination is an important motivator of both domestic and international tourism (*29*), in particular when students studying abroad are concerned (*30*). Secondly, social networks are gaining popularity for both branding and promoting urban tourist destinations, as well as searching for information and organizing holiday trips (*31*). Last, social networks offer the possibility to collect a large international sample with relative ease, low cost, high quality and reliability (*32*). In order to verify the sample reliability, the respondents were offered to participate in a raffle of 10 "I cycle Copenhagen" T-shirts as an incentive for providing their contact details.

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 for transport survey administration via social media (*32*). 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 (*23*). 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 with less visible cycling culture and much higher tension between cyclists and motorists.

RESULTS

Sample characteristics and preferred holiday scenario

The survey yielded 801 questionnaires, of which 655 (81.8%) were completed without missing data, and thus were used for data analysis and model estimation. The sample size is much larger than Nunnally's (*33*) 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 indicate that 45.2% of the respondents are male, 23.5% are less than 25 years-old, 53.3% are between 25 and 34 years-old, 12.4% are between 35 and 44 years-old, and 10.8% are over 45 years-old. The respondents mainly live (79.7%) or previously lived long-term (93.9%) in a cycling-friendly country, but 51.9% rarely or never cycles, 12.4% cycles 2-3 times per week, and only 20.8% cycles daily. Respondents are heterogeneous in using the car daily (37.6%), 2-3 times per week (16.9%) or rarely (26.3%), and also in using public transport daily (24.1%), 2-3 times per week (15.1%) or rarely (39.7%). Most respondents have more than 5 years experience cycling (68.5%), and their purpose is quite homogeneously divided between utilitarian, recreational or both.

The respondents in the sample show interest in holiday cycling, having the majority visited cycling-friendly cities once or twice (47.8%) or often (16.5%), with Copenhagen and Amsterdam as the preferred destination (44.2%). While on holiday, respondents rented a bicycle once or twice in 32.2% of the cases and often in 7.0%, while only a small percentage brought their own bicycle on vacation once or twice (7.9%) or often (3.5%). In comparison, 51.5% of the respondents never rented a car and 85.6% often used public transport. While in their FMTT about the preferred holiday in Copenhagen, 73.1% prefer to stay approximately one week, 16.0% two weeks, and 10.9% for longer periods, with the preferred accommodation being bed&breakfast (33.1%) followed by 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, either a friend or spouse (54.5%), several family members (12.4%), or a group of friends (31.8%). Part of the respondents perceive that their accompanying persons are highly likely to cycle (28.7%) or likely to cycle (36.8%), but also that some are not (19.8%).

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, and among these the majority (60.5%) did not express a preference between regular and electric bicycles, with part preferring a regular bicycle (31.3%) and only a few the electric one (8.2%). Most respondents (48.4%) intend to cycle daily or 2-3 times a week (36.5%), and only a minor part (15.1%) once a week or less. Their interest is mainly to cycle in natural areas and parks (89.5%), around the city (86.0%), and with friends and family (80.2%), and far less to cycle 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.

Attitudes, subjective norms and perceived behavioral control related to holiday cycling were initially elicited by means of exploratory 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, at both the overall (KMO = 0.797) and the single item level (KMO = 0.538 - 0.906). Exploratory principal axis factor analysis with Varimax orthogonal rotation uncovered four factors: “pro-cycling attitudes”, “interest in bicycle technology”, “pro-cycling subjective norms”, and “perceived cycling ease”. As the four factors were related to the items obtained in the survey within the measurement equations of the SEM and Shapiro-Wilk normality tests rejected the null hypothesis of normal distribution of the items, the model parameters were estimated simultaneously by using Maximum Likelihood with Huber-White covariance adjustment (*26*).

Tables 1 through 5 present the model parameter estimates and their critical ratios (C.R.): measurement equations in Table 1, structural equations linking the TPB constructs to tourists characteristics in Table 2, structural equations linking the intentions to rent different types of bicycle to the TPB constructs in Table 3, and structural equations relating the cycling frequency and multi-purpose intentions to the TPB constructs, preferred bicycle type, and relevant holiday scenario characteristics in Table 4. Table 5 presents the estimated covariance matrix for the latent constructs. 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), the RMSEA is equal to 0.051, and the SRMR is equal to 0.064, which are well below the maximum accepted values of 5, 0.08 and 0.10. 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 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. Pro-cycling attitudes are also linked positively to frequent holidays in cycling-friendly cities and negatively to habitual weekly transit use.

Interest in bicycle technology is related to habitual daily car use and rarely or never spending holidays in cycling-friendly cities, and it is also associated negatively with current or past residence in a cycling-friendly country and positively with frequent bike rental on holidays.

TABLE 1 Measurement Equations

Pro-cycling attitudes (F1)			Interest in bicycle technology (F2)		
Variable	Est.	C.R.	Variable	Est.	C.R.
DanCyc	1.000	--	Ebtech	1.000	--
Envhol	1.009	17.45	Ebfast	0.999	26.29
Acthol	0.881	16.03	Ebgps	0.696	21.82
Savmon	1.014	17.59			
Cycnowt	1.233	21.03			
Cycconv	1.194	20.77			
Cyclong	0.409	6.86			

Pro-cycling subjective norms (F3)			Perceived cycling ease (F4)		
Variable	Est.	C.R.	Variable	Est.	C.R.
Cycfam	1.000	--	Cycweat	1.000	--
Cycpop	1.205	19.89	Cyclong	1.093	12.77
Cycrec	0.618	11.27	Cycint	0.923	12.62
Cycrec	0.690	12.29	Cycbump	0.618	9.00
Cycngt	1.120	18.21	Cycgps	0.700	9.99
Cycroad	1.158	17.66	Cycpay	0.507	7.61
Cycmxtr	0.762	13.18	Cycsec	0.706	10.16
Cycchild	0.958	16.11			
Cycpark	-0.872	-13.88			
Cycresp	1.181	18.89			

Positive subjective norms towards cycling are stronger 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.

Perceived cycling ease is positively related to (i) male respondents, (ii) habitual daily cyclists, (iii) experienced cyclists, and (iv) rarely renting bicycles on holiday, and is negatively related to frequent daily or weekly car and transit use. Also, it is related positively to cycling for both recreational and utilitarian purposes and negatively to living in a cycling-friendly country.

Preferences towards bicycle types for holiday cycling are related to the TPB constructs. A clear preference towards renting a regular bicycle is positively related to higher perceived cycling ease and lower interest in bicycle technology, as well as having stronger pro-cycling subjective norms. A clear preference towards an electric bicycle is associated with greater interest in bicycle technology, lower perception of cycling ease, and weaker subjective norms towards cycling. Intentions to rent either a regular or an electric bicycle are positively linked to pro-cycling attitudes, interest in bicycle technology, higher perceived cycling ease, and 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.

TABLE 2 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 3 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 more frequently are positively related to: (i) stronger pro-cycling attitudes, pro-cycling subjective norms, and perceived cycling ease; (ii) a clear preference for renting regular bicycles; (iii) a greater perceived likelihood that the holiday travel partners would cycle. Moreover, holiday cycling frequency is related positively to the interest in bicycle technology and negatively to the perceived intentions to use motorized modes during the hypothetical holiday scenario.

TABLE 4 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

Intentions to cycle for multiple purposes are positively associated with: (i) stronger pro-cycling attitudes, interest in bicycle technology, and perceived cycling ease; (ii) clear preference towards regular bicycles; (iii) a greater perceived likelihood that the holiday travel partners would cycle. They are also negatively related to the preference to rent either a regular bicycle or an electric bicycle without a clear preference between the two options. Interestingly, the intentions to cycle for multiple purpose and intentions to cycle frequently during the holiday are weakly but significantly positively correlated.

TABLE 5 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

DISCUSSION AND CONCLUSIONS

This study is the first to explore the behavioral factors motivating the intentions to use urban bike-sharing for cycling by potential tourists. The results stimulate thoughts about policy implications for tourism management and transport planning.

Firstly, bike-sharing is highly attractive for potential tourists as part of a short urban holiday and as a frequent multi-purpose activity. Cities that consider expanding their attraction as tourist destinations could benefit fom bike-sharing schemes and bicycle infrastructure as an integral part of the touristic experience and could use the cycling experience as part as their branding strategy. In Denmark, although cycling is a Danish tourism brand and 25% of tourists cycle during their stay, cycling tourism is mainly developed in connection with coastal and nature tourist attractions, and only 16% of current cycling tourism is related to the capital area, partly because of the limited access to bikes for short time usage. In this context, the new bike-sharing system bears the potential of allowing a new form of tourism to be developed and a new city branding strategy to be designed. Notably, the high potential demand obtained in this study could be related to the particular pricing structure that is cheaper than both the transit use and the car rental options, and hence attracts young adults who travel with a limited budget. In touristic locations with lower transit and car rental prices, the price scheme of bike-sharing system should be designed to provide a sufficiently attractive alternative.

Secondly, accomodating the needs of tourists as a large demand group should be embedded in the planning of cycling facilities. While residents engage in both utilitarian and recreational cycling, tourists mainly cycle around in the city and parks with friends and relatives. Alongside functional routes that follow the shortest path and are integrated with the transit system, circular city routes that combine scenic and historical areas and are wide enough to travel in pairs or groups better suit the needs of tourists. Moreover, while in several bike-sharing systems the use patterns are traced and mapped for the entire population of users, the results of this study indicate that transport planners would benefit from differentiating use patterns by demand groups, namely tourists, commuters, residents and occasional users.

Thirdly, the behavioral intentions for holiday cycling are driven by favorable attitudes toward cycling, interest in bicycle technology, and perceived cycling ease. Favorable attitudes toward cycling are related to being physically active while on holiday, having an environmentally friendly vacation, and having greater convenience in saving money and time. The interest in bicycle technology is related to using the GPS device, riding faster and more easily, and having a high-tech vibe around. Perceived cycling ease is associated with concerns about weather, distance, traffic, crowding, GPS use while cycling, and paying automatically. Cycling ease and lack of interest in bicycle technology are the most important factors for preferring regular bicycles, while the interest in bicycle technology motivates choosing electric bicycles. These factors could be taken into consideration for cost-effectively branding of bicycle types to tourists by matching the branding strategy to tourists who are likely to be interested in a specific bicycle according to their use patterns.

Fourthly, the demand for electric bicycles is much lower than for regular ones, a relevant finding given the higher purchase and operating costs and greater safety concerns associated with electric bicycles. Therefore, cities that consider investing in a new bike-sharing system should not focus on electric bicycles, but on regular ones that can be upgraded, as the bicycle solution currently offered in Copenhagen.

Last, favorable attitudes toward cycling, interest in bicycle technology, favorable norms toward cycling, and perceived cycling ease are significantly related to living in a cycling-friendly country, habitual transport mode choice, and interest in cycling tourism. People residing in non cycling-friendly countries exhibit lower subjective norms and higher enthusiasm towards using the bike-sharing system, diametrally opposite to people living in cycling-friendly countries. Possibly, the latter are less enthusiastic about cycling because they cycle from early childhood and perceive it as a natural and integral part of their daily life. Also, while tourists from cycling-oriented countries may use the bike-sharing system as a transport mode because of habit, tourists from non-cycling countries may use the system due to their enthusiasm to experience cycling as a new activity during their holiday. These considerations lead to different marketing strategies: while current tourists from the Netherlands and Germany bring their bicycles in their own car, and hence require information about the city via word-of-mouth sources (e.g., 'TripAdvisor') or signal systems, marketing strategies could address the remaining tourists in their country of origin by proposing activities enhancing the tourist experience such as guided city tours by bicycle and one day cycling courses.

Further research includes three research directions. Firstly, research exists for local cyclists (*34*) about cycling motivation, cycling experience, and correlation with the urban environment, but does not exist for tourists. When the system is operative, the route choice of tourists, their cycling experience in Copenhagen and its contribution to the holiday experience can be explored. Secondly, while this study focused on tourist demand for bike-sharing upon their arrival to their holiday destination, further research could explore whether the experience of riding a bike on holiday by using the bike-sharing system has an influence on people's transport behavior when they return home. Last, while this study explored the demand by using a stated preference survey among potential tourists, it is important to explore the revealed preferences for renting a bike versus other transport modes in cities where such systems operate.

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