MODIFICATION OF TRAVEL BEHAVIOR BY E-COMMERCE? CAPTURING RELEVANT FACTORS BY AN ADAPTED SURVEY APPROACH BASED ON PREVIOUS RESEARCH

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ABSTRACT

Electronic commerce has grown strongly in recent years and provides consumers with new opportunities to meet their demand. The necessity to make trips for shopping purposes is becoming increasingly less important for both the provision of food but also for other goods. Against this background, the relevance of the car as a tool for the supply for a household can be questioned. It appears that new considerations are required to broaden the understanding of travel-related needs of households. Research in this context is faced with the question of how individuals' overall travel behavior and a perceived necessity for car use are likely to be modified through e-commerce. Amongst other aspects, travel behavior research is challenged by designing appropriate survey concepts. In order to derive a holistic picture of people's travel and shopping behavior also the attitudes towards different modes of transport and shopping behavior need to be considered. This paper presents an integrated survey approach, which makes it possible to capture these aspects comprehensively. The explorative methods used for this work contain a comprehensive literature review, the streamlining of an existing survey approach regarding urban travel behavior and its extension with shopping-related and psychological aspects. In our study, we first tested this extended approach and the attitudinal questions in a pretest. Subsequently, we validated the attitudinal questions with a factor analysis and identified three latent variables: pro-delivery, technology criticism, and in-store attitudes. The results can serve as input for further studies on e-commerce and travel behavior.

Keynotes: Home deliveries, travel skeleton, shopping travel behavior, psychological factors

INTRODUCTION

In transport planning, a lot of research is being done on mobility-related services and how they are changing behavior. Digital technologies can make a significant contribution to this process: As a driver of tomorrow's travel behavior, the continuously progressing development of information and communication technology (ICT) is changing the way how people work, shop and live (*1*). From the broad research field of ICT, we narrowed the focus of this work to the online shopping activities of consumers. In this context, new forms of shopping have been created and lead to changes in shopping and travel behavior. Electronic commerce (e-commerce) allows a supply of households with goods by fewer everyday trips and thus significantly reduce people's need for travel. The broader impact of e-commerce can be seen in the context of different time horizons and individuals' choices regarding lifestyle, mobility as well as activities and travel (*2*). Especially travel can be affected regarding the following aspects:

1. the volume we travel, i.e., trip frequencies and vehicle kilometers driven
2. the use of transport modes

Based on Salomon's (*3*) publication Mokhtarian (*4*) identified four potential impacts of home delivery services on the extent of an individual's travel: substitution implies that physical trips are replaced or shortened, complementarity prevails if additional trips are created, modification describes the changing of spatial and temporal path patterns and neutrality is present if ICT use and travel behavior are not interrelated. These four effects, in particular substitution and complementation, represent the most important hypotheses for changes in transport demand and in most cases relate to the number of trips made in general or for shopping purposes. In this context, the modification of individuals' travel behavior has to be seen in a wider context of influencing parameters. Especially shopping is an activity that underlies a certain complexity. Access to information through the internet opens up new and more attractive destinations for individuals, which can be even more distant. Simultaneously, the internet results in a temporal and spatial fragmentation of the shopping process (*5, 6*) and other activities as well as a more efficient organization of trips (*7*). Further, the time saved by online shopping can be invested in other activities causing trips. Finally, individuals like to shop and see shopping not only as a compulsory activity but also as a leisure activity with social and experience-oriented value (*8*).

The use of modes can be affected by home deliveries as they can serve as a partial substitute for car trips. Both Weltevreden (*9*) and Gould and Golob (*10*) identified the car as a necessary instrument for people to handle their shopping. Basically, shopping trips have the potential to create a car dependence because purchased goods need to be carried home. So far, regarding the decision to transport goods by oneself or third-parties, interviewees currently prefer to transport the goods themselves (*11, 12*). Nevertheless, it is a frequently expressed hypothesis in literature, that the option of third-party delivery may in the future represent an important component in coping with transportation needs and thus promote car-free living. At the same time, the car can regain importance by the spatial redistribution and dilution of retail locations and thus cause a contrary effect (*2*).

Most recently, travel behavior research anticipates a fundamental change in the travel behavior of individuals. Acknowledged travel behavior studies such as the Mobility in Germany (MiD) and the German Mobility Panel (MOP) observe changes in individual travel volumes. For example, the average number of trips per day indicates a slight tendency towards a decline, especially for men and younger persons (*13*). So far, no scientifically based explanation for this trend exists. A substitution of shopping trips through deliveries has been so far assumed to be one

possible explanation, amongst others. In this context, the literature raises the question of how the transport sector as a whole will change structurally as a result of new delivery services.

Considering the future of car ownership, it is important to understand how people depend on their private car, what they use their car for in everyday life, and how open-minded they are to using delivery services that can replace private car trips. Going one step further, the issues about the sociodemographic characteristics of people that are substituting their travel for services provided by third-parties is a further interest of research. The adaptation to services, such as e-commerce, is determined by obvious motives, but also by psychological aspects. Since attitudes and norms are of importance to understand travel behavior (19, 20), their explanatory potential regarding shopping travel behavior attracts the attention of researchers. Furthermore, for the use of services and, in particular, the online purchasing of goods, a certain tech-savviness is a necessary precondition. People who have the ability and willingness to use technologies are expected to have a greater potential for substituting their own travel on the basis of home deliveries. Therefore, an essential goal is the description of the characteristics of individuals who are more responsive to the use of delivery services.

The difficulty of this scientific objective lies in the availability of suitable data. In this context, existing studies claim to complement surveys concentrating on shopping and travel behavior with psychological and profound travel-related aspects (*1, 14*). For appropriate analyses an integrated picture of people's travel and shopping behavior must be captured. Therefore, a suitable and appropriate survey instrument is needed. In its function it must be able to fully depict both individual travel and shopping behavior and simultaneously incorporate psychological aspects relating to shopping and technologies as well as transport modes. Such a kind of approach defines the gap in literature this work aims to close.

The paper is structured as follows: First, we give an extended overview on related literature that deals with the relationship between shopping and travel behavior and applied survey structures. Second, we describe the development of the survey design and the data collection in this work. Third, we present the results that contain descriptive analyses and a common factor analyses to identify latent variables. Fourth, we discuss our results and the limitations of this work. Finally, we draw a conclusion and refer to further work.

LITERATURE REVIEW

As mentioned above, researchers expect a transformation of individual travel behavior due to e-commerce (*2, 15*). Therefore, research about the impacts of home deliveries on personal travel has been performed since the 90ies. One of the first studies in this field was presented by Gould and Golob (*16*), expecting complex interactions between communication technology and transportation. Since then, the relationship between travel and shopping behavior has become a relevant research topic. A growing body of related studies has arisen from different disciplines dealing with this issue. An previous overview of empirical shopping studies is given by Cao (*1*) and Weltevreden (*14*). In the scope of this work, a more extended literature review has been conducted. As the existing investigations differ methodically and in their focused objectives a classification of present studies in this field is expedient. Therfore, this section will give a detailed overview and classification of the literature in this field in form of a table (Table 1).

The aim of this tabular summary is to provide a compact review on related research and to give deeper insights into the data, thematic focus, the integration of psychological aspects (attitudes towards shopping), the consideration of technological aspects and the method of

analysis. Correspondingly, the columns of the table are named. Within the table, the references are listed alphabetically (and by year) so that related research by the same authors can be identified. Table 1Table 1 is structured as follows: the studies were subdivided into five categories according to their main research interests and topics. Within the table, corresponding headings are used to separate these categories into sections. A differentiation can be made between

1. conceptual studies on shopping
2. empirical shopping studies
3. travel behavior studies used for analyzing shopping behavior
4. further studies regarding shopping with specific research orientation
5. studies regarding attitudes towards shopping

Conceptual studies are rather of a theoretical nature. They have not collected and evaluated any data themselves but attempt to summarize the literature and derive statements for future research. Their conceptual approaches bring transparency and provide important impulses for other scientists in this field. On the contrary, various empirical studies have been performed to investigate the relations between shopping and travel behavior. Here, Cao (*1*) considered the survey context and distinguishes between surveys only referring to shopping and travel behavior surveys that were, inter alia, used to analyze shopping behavior.

Thereby, typical *empirical shopping* surveys contain shopping-related elements, e.g., shopping behavior for both online and in-store shopping, and socio-demographics. The collected quantitative data were primarily analyzed in a descriptive manner (assuming trip substitution or complementary effects on a traffic-related or at least individual level). These surveys record shopping behavior to a high degree of detailing. However, they mostly miss to establish the connection to general travel behavior and have incorporated attitudes towards shopping only in some cases.

The advantage of using a *travel behavioral* framework is the possibility to derive statements on activity-based shifts and multidimensional effects on travel induced by individual's use of e-commerce. The limitation of this kind of surveys often results from a lack of detailed information on shopping behavior. Although some recent travel behavior studies extend their questionnaire with special shopping related aspects, they nevertheless miss to incorporate attitudes so far as can be seen in Table 1.

A further category is built up by studies with *specific research orientation*. Their main research questions point at, for example, spatial or choice-related investigations. Due to their profound results they are worth mentioning but have to be seen separate from classical empirical studies that focused on quantifying the extent to which individuals' travel changes.

Finally, the literature already refers to a considerable number of studies addressing *attitudinal questions about shopping* behavior. Psychological items are used for different applications: the segmentation of "shopping types", for modelling behavioral structures (such as structural equation models (SEM)) or as a basis for theory-based models for forecasting.

1 **Table 1. Literature overview – part 1**

Conceptual studies on shopping				
Reference	**Data**	**Thematic focus**	**Att. Tech.**	**Method of analysis**
Cao (2009) (*1*)	-	Evaluation of research progress and discussion of research methodologies	-	Literature review
Cao and Mokhtarian (2005) (*17*)	-	Theoretical framework, dependent variables, methodologies and determinants of the adoption of online shopping and online shopping bevahior	-	Literature review
Chang et al. (2005) (*18*)	-	Determinants that influence the adoption of online shopping and their relationship to one another	-	Literature review
Coucelious (2004) (*6*)	-	Fragmentation of the shopping process and activities	-	Hypothesizing
Moktharian (2004) (*15*)	-	Transportation impacts of e-commerce relating to mode share, volumes of goods purchased, per capita consumption, demography	-	Literature review and hypothesizing
Rotem-Minadli and Weltevreden (2013) (*19*)	-	Discussion of the causes of the various results in empirical shopping studies	-	Literature review
Visser and Lanzendorf (2004) (*2*)	-	Mobility and accessibility effects of e-commerce regarding individual activity patterns and travel behavior, freight transport and logistics, location decisions of households and firms	-	Literature review

1 **Continuation: Table 1. Literature overview – part 2**

Empirical shopping studies

Reference	Data	Thematic focus	Att. Tech.	Method of analysis
Cao et al. (2010) (*20*)	Online shopping survey (n=539), Minneapolis-St. Paul metropolian area	Impact of online on in-store shopping	YES YES	Descriptive analysis, Ordered probit models
Cao et al. (2012) (*21*)	Online shopping survey (n=539), Minneapolis-St. Paul metropolian area	Interactions between online searching, online buying and in-store shopping	YES YES	SEM
Cao (2012) (*5*)	Online shopping survey (n=539), Minneapolis-St. Paul metropolian area	Interactions between online and in-store shopping in the steps of the process	YES YES	Binary logit model
Douma und Wells (2004) (*7*)	Mixed: Online shopping survey with 4-day travel diary (n=446), Minnesota	Patterns between internet use and shopping trips	NO NO	Descriptive analysis
Farag et al. (2005) (*22*)	Shopping survey (n=826), The Netherlands	Impact of online searching on shopping trips	YES NO	Descriptive analysis, Path analysis
Farag et al. (2007) (*8*)	Mixed: Shopping survey with 2-day travel diary (n=826), The Netherlands	Relationship between online shopping and shopping trips	YES YES	SEM
Kriezek et al. (2005) (*23*)	Online survey (n=744), 2003, Seattle, Kansas City, Pittsburgh	Pattern of substitution between traditional and ICT-form activities (trips)	NO YES	Descriptive analysis, logistic regression
Lee et al. (2017) (*24*)	Online survey (n=2043), Carlifornia	Relationship between online and in-store shopping frequency	YES YES	Pairwise copula-based ordered response models
Lenz et al. (2015) (*25*)	Shopping panel data (n=1945), 2003 und 2007, Deutschland	Changing physical shopping behavior (trips) due to starting to buy online	NO NO	Descriptive analysis
Rotem-Mindali (2010) (*26*)	Face-to-face interviews (n=486), Tel-Aviv, 2004	Impact of information technology on shopping travel behavior	NO YES	Descriptive analysis
Tonn und Hemrick (2004) (*27*)	Online shopping survey (n=118), Knoxville, Tennessee	Impact of e-mail and internet use on personal trip-making	NO YES	Descriptive analysis
Weltevreden (2007) (*14*)	Online shopping survey (n=3200)	Change of city center shopping due to search process	NO NO	Descriptive analysis
Weltevreden und van Rietbergen (2007) (*28*)	Online shopping survey (n=4684), The Netherlands	Impact of city center attractiveness on shopping trips	NO NO	Multinomial logistic regression, Binomial logistic regression
Weltevreden and Rotem-Mindali (2009) (*29*)	Online shopping survey (n=3000), 2006, The Netherlands	Quantification of the impact of e-commerce on personal travel (trips)	NO NO	Descriptive analysis

1 **Continuation: Table 1. Literature overview – part 3**

Further studies regarding shopping with specific research orientation

Reference	Data	Thematic focus	Att. Tech.	Method
Corpuz and Peachman (2003) (*30*)	Sydney Household Travel Survey (HTS)	Impacts of internet usage on travel behavior	NO NO	Descriptive analysis
Farag et al. (2003) (*31*)	E-shopping dataset by Multiscope (n=2190), Nethlerlands National Travel Survey (NTS)	Impacts of the use of online-shpping on persnal travel behavior	NO NO	Descriptive analysis
Ferell (2004) (*32*)	Bay Area Travel Survey (BATS), 2000, San Francisco	Effects of online shopping on shopping travel behavior	NO NO	Own models
Ferell (2005) (*33*)	Bay Area Travel Survey (BATS), 2000, San Francisco	*Model:* Ananlysis of peoples activities considering time use for shopping online & in-store	NO NO	SEM
Gould and Golob (1997) (*16*)	2-day travel diary (n=7000)	Substitution of shopping trips	NO NO	Descriptive analysis
Hoogendoorn-Lanser et al. (2015) (*34*)	Netherlands Mobility Panel (NMP) (n=2500), 2013	Impacts of e-commerce on overall travel behavior	NO NO	Descriptive analysis
Hoogendoorn-Lanser et al. (2019) (*35*)	Mixed: Shopping survey + Netherlands Mobility Panel (NMP) (n=1711)	fragmentation of shopping process	NO NO	Descriptive analysis
Zhou und Wang (2014) (*36*)	National Houshold Travel Survey in North America (NHTS)	*Model***:** Relationship between online shopping and shopping trips	NO NO	SEM

Continuation: Table 1. Literature overview – part 4

Further studies regarding shopping with specific research orientation				
Reference	**Data**	**Thematic focus**	**Att. Tech.**	**Method**
Farag et al. (2006) (*44*)	Dutch e-shopping dataset by Multiscope (1996: n=1172, 2001: n=2190)	Impact of *geography* on shopping trips in temporal comparison of 1996 and 2001	NO NO	Descriptive analysis, Regression analysis, Logistic Regression analysis
Hsiao (2009) (*43*)	Personal interviews with stated preference questionnaires (n=300),	*Choice* between online shopping and physical store shopping	NO NO	Binary logit
Ibrahim (2003) (*10*)	Qualitative interviews (n=30), Quantitative Interviews (n=675)	*Mode Choice* for shopping purposes	NO NO	Descriptive analysis
Joewono et al. (2019) (*37*)	Paper survey (n=520) , Indonesia	In-store shopping activities and travel behavior (mode choice) in *developing countries*	NO NO	Classification analysis, Factor analysis, Cluster analysis, Ordered model
Maat and Konings (2018) (*38*)	Personal survey (n=534), The Netherlands	*Spatial* accessibility or innovation as reason for online shopping	YES YES	Binary logit model, Fractional logit models
Ren and Kwan (2009) (*41*)	Online shopping survey (n=392)	Impact of *geography* on e-shopping adoption	NO YES	Logistic regression, negative binomial regression, linear regression
Rotem-Mindali und Salomon (2009) (*42*)	Face-to-face interviews (n=510), Tel-Aviv	Consumers *Choice* to buy online	NO YES	Descriptive analysis
Schmid et al. (2016) (*39*)	Stated preference experiment (n=339)	*Choice* between online shopping and physical store shopping	YES NO	Integrated Choice and Latent Variable model, Descriptive analysis
Wiese et al. (2015) (*40*)	*Qualitative* interviews (n=15)	Influencing factors on shopping travel behavior of different shopping types	NO NO	*Qualiative* analysis

Continuation: Table 1. Literature overview – part 5

Studies regarding attitudes towards shopping				
Reference	**Data**	**Thematic focus**	**Att. Tech.**	**Method**
Goldsmith and Goldsmith (2002) (*51*)	Online survey (n=566), US	*Types:* Distinction of consumers on the basis of attitudes	YES YES	Principal components analysis, CFA, MANCOVA
Hernández et al. (2011) (*45*)	Computer-assisted telephone interviews (n=255), Spain	*Model:* Influence of sociodemographic aspects on online shopping behavior	YES YES	SEM (TAM)
Hsu et al. (2006) (*47*)	Survey sessions (n=201), Taiwan	*Model:* Intention to continue to shop online	YES YES	SEM (TPB)
Mokhtarian et al. (2009) (*46*)	Online shopping survey (n=966)	*Types:* Shopping type identification by using attitudes	YES YES	Exploratory factor analysis, cluster analysis
Rohm and Swaminathan (2004) (*48*)	Online shopping survey (n=429 online shoppers, n=101 offline shoppers)	*Types:* Distinction of consumers on the basis ofshopping motivations	YES NO	Factor analysis
Swinyard and Smith (2003) (*50*)	Online shopping survey (n=1738)	*Types:* Shopping type identification by using attitudes	YES YES	Principal-components analysis, cluster analysis
Walczuch und Lundgren (2004) (*49*)	Paper survey (n= 149), The Netherlands	*Model:* Psychological aspects of consumer trust in e-retail	YES YES	Regression analysis

SURVEY DESIGN, DATA COLLECTION AND SAMPLE CHARACTERISTICS

In this section, we present our methodological survey approach and some initial empirical data we collected to investigate individuals shopping activity and its relationship to travel behavior. This data has to be considered as a pretest sample and was mainly used to evaluate the survey concept.

Survey design

The collection of travel behavior data was realized by means of a travel skeleton approach by (*52*). This design was developed as an alternative option to time-consuming longitudinal travel diaries. It supplies a method to capture the typical travel behavior of individuals. The skeleton comprises elements on everyday and long-distance travel as well as socio-demographic data. In addition, this approach includes a standardized and well-tested psychological item set (indicators) about the attitudes and norms towards different travel modes. The travel skeleton records no explicitly single trips by distances or durations etc. in the sense of a diary approach. It rather captures everyday travel on a broader framework by questioning respondents' personal assessment of their personal travel behavior. With a view to fully capture individual’s travel behavior, this skeleton built the travel related framework for this study.

This approach was supplemented by questions on shopping behavior and the use of home delivery services. The collection of transport related behavioral data was realized by questions about the number of shopping activities (trips and deliveries) during a two-week period. In particular, trips were captured in detail for the purposes window-shopping, visit of specialist shops

and further errands. Relating aspects such as the use of a private car for these trips and the shopping facilities within the residential environment were also questioned. Additional questions refer to individuals' private transports and the use of digital services in general.

As the literature has shown, individual's attitudes towards online shopping and shopping in general have been early identified as aspects of essential meaning for the adaption of e-commerce. The findings from previous research have been refined to integrate relevant aspects for the use of home delivery services, such as the price and time pressure as well as the trust in online retailers and individual's tech-savviness. Based on the literature, the skeleton approach was complemented with another set of psychological items, i.e., attitudes towards shopping and delivery services as well as the use of technology. Some concepts for the requesting of tech-savviness in relation to shopping and travel behavior can be found in literature (*8*, *12*, *21*, *24*, *50*). In that respect, only few authors already questioned attitudes towards technology. In doing so, this enables to generate compact information regarding individual's usage intention. Finally, social norms and values regarding shopping have also been included into the new set since their relevance to explain mode choice in travel behaviour research is already known (*53*). Table 2 lists the 27 psychological items belonging to this compiled set. The items are rated on a Likert scale from 1-5 ("does not apply" to "apply").

Table 2. Psychological shopping items (indicators) used in the study

Description	*Items*	*Questions*	*References*
Positive attitude towards delivery services	I_1^{PDS}	Carrying purchases home when walking or bicycling is a hassle.	(*24*), (*50*), individually created
	I_2^{PDS}	I like that no car is necessary on online shopping.	
	I_3^{PDS}	I like having merchandise delivered to me at home.	
	I_4^{PDS}	I'm used to transporting things myself.	
Negative attitude towards delivery services	I_1^{NDS}	I don't like the delivery problems and returns when shopping online.	Adjusted according to (*50*)
	I_2^{NDS}	I dislike shipping charges on the internet.	
	I_3^{NDS}	I don't like waiting for products to arrive.	
Positive attitude towards shopping in-store and in general	I_1^{INS}	Even if I do not end up buying anything, I still enjoy going to stores and browsing.	(*46*), (*50*), (*24*), (*20*)
	I_2^{INS}	I like shopping.	
	I_3^{INS}	Shopping is usually a chore for me.	
Sensitivity for time use and prices	I_1^{T}	It is important to me to get the lowest prices when I buy things.	(*46*), (*50*), (*24*), individually created
	I_2^{T}	I am too busy to shop as often or as long as I would like	
	I_3^{T}	Having goods delivered saves time.	
Trust in online retailers	I_1^{TR}	It is risky to buy over the internet.	(*51*), Adjusted according to (*49*)
	I_2^{TR}	I trust e-retailers with respect to contact data and my credit card information	
Positive attitude towards technology and innovation	I_1^{PTI}	I like to track the development of new technology.	(*46*), (*24*)
	I_2^{PTI}	New technologies bring at least as many problems as it does solutions.	
	I_3^{PTI}	I am generally cautious about accepting new ideas.	
	I_4^{PTI}	I prefer to see other people using new products before I consider getting them myself.	
	I_5^{PTI}	I like a routine.	
Ability to use technological applications	I_1^{A}	I'm good at finding what I want on internet.	Adjusted according to (*50*), individually created
	I_2^{A}	Internet ordering is hard to understand and use	
	I_3^{A}	I find it easy to learn the use of a new app on the smartphone.	
Personal and social norm	I_1^{NORM}	I don't like it when parcels are handed to my neighbors.	Individually created according to (*53*) and on basis of a qualitative preliminary study.
	I_2^{NORM}	People who are important to me think it is good if I shop in retail stores instead of on the internet.	
	I_3^{NORM}	Due to my personal values I feel personally obliged to shop as less as possible on the internet.	
	I_4^{NORM}	It is important to me to support local retailers through my shopping decision.	

Altogether the evolved survey approach incorporated underlying attitudes towards shopping and travel modes in parallel with behavioural data regarding travel in general and shopping. The overall concept of the questionnaire is illustrated in Figure 1.

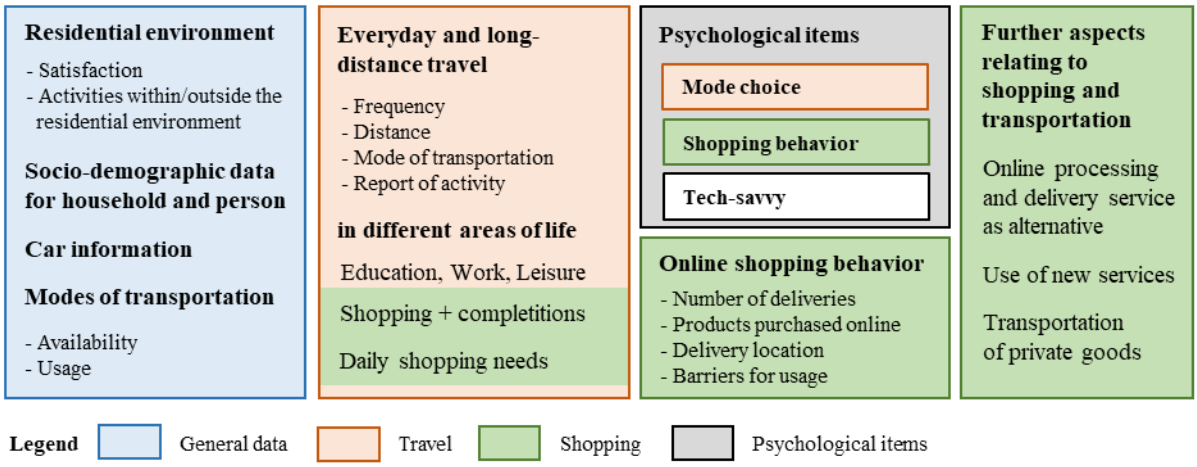

Figure 1. Overall survey concept

Data collection and sample characteristics

For the pretesting of the developed approach a data collection has been conducted between February and March 2019. The survey has been implemented and carried out as a web-based survey due to efficiency reasons. Altogether 191 respondents complemented the survey and 167 valuable observations remained after plausibility checks.

The sample is characterized by gender balance, highly educated people and mainly young people (75% under the age of 35). The occupational status contains a share of 54% of full-time employed respondents and 30% students. 41 % of the respondents can dispose of a car permanently. The sample was basically urban.

RESULTS

For travel behavior research it is of relevance to derive clarifications about the interrelation of everyday travel, car ownership and the delivery of goods. The use of e-commerce and the associated changes in travel needs are always related to the overall everyday travel of individuals. For this reason, a definition of mobility types, can help to improve the understanding for the interrelation and the potential developments of travel behavior and e-commerce. The following scope of analyses then includes both the travel behavior of online shoppers (frequent orderers) and in-store shoppers and the shopping behavior of different mobility types. Therefore, we first categorized the following types of mobility based on the reported modal behavior of the respondents: Cyclists (19%), public transport (8%) as well as daily car-oriented (11%) travelers, mixed users (41%) who use different means of transport daily or weekly, and multiple users (21%) who use both car and bicycle as well as public transport at least once a week. In this context, it should be mentioned that many people in this sample behave multimodally using several modes at least once a week. Secondly, we determined factors, so-called latent variables (LVs), from the standardized item set by (*53*) towards different modes of transport to reduce complexity of the

collected data. For this data reduction the method of principal component analysis was used as already applied in (*54*). For reasons of interpretability and assignability, the same five-factor solution (confirmed by the scree-test) was chosen. Especially the factor car-excitement could be extracted as a LV to describe people's preference and positive attitude towards car use. As a result, a behavioral classification of mobility types as well as LVs related to attitudes towards modes of transport are available. These form the enhanced travel-related framework that is included into the following analyses of shopping behavior.

Next, the new compiled item set regarding shopping is the main subject of investigation. The answers of the indicators regarding shopping are summarized in Figure 2. Overall, the distribution of the answers is reasonable for most of the items. This, in particular, counts for the new developed items addressing social and personal norms (I_x^N). As can be seen in the unbalanced ratio of red and green components, individual items were answered in the marginal areas of the scale (I_1^A, I_2^A, I_3^A, I_4^{PDS} and I_2^{NDS}). This items will make little contribution to explaining variance in behavior. The black components show an increased number of missings for some items. I_2^{PDS} and I_2^N were removed to increase the amount of usable observation from 86 to 116 in the affiliating factor analysis. Such a comparably small sample size has been applied and delivered valid and robust results to this extent (*55*).

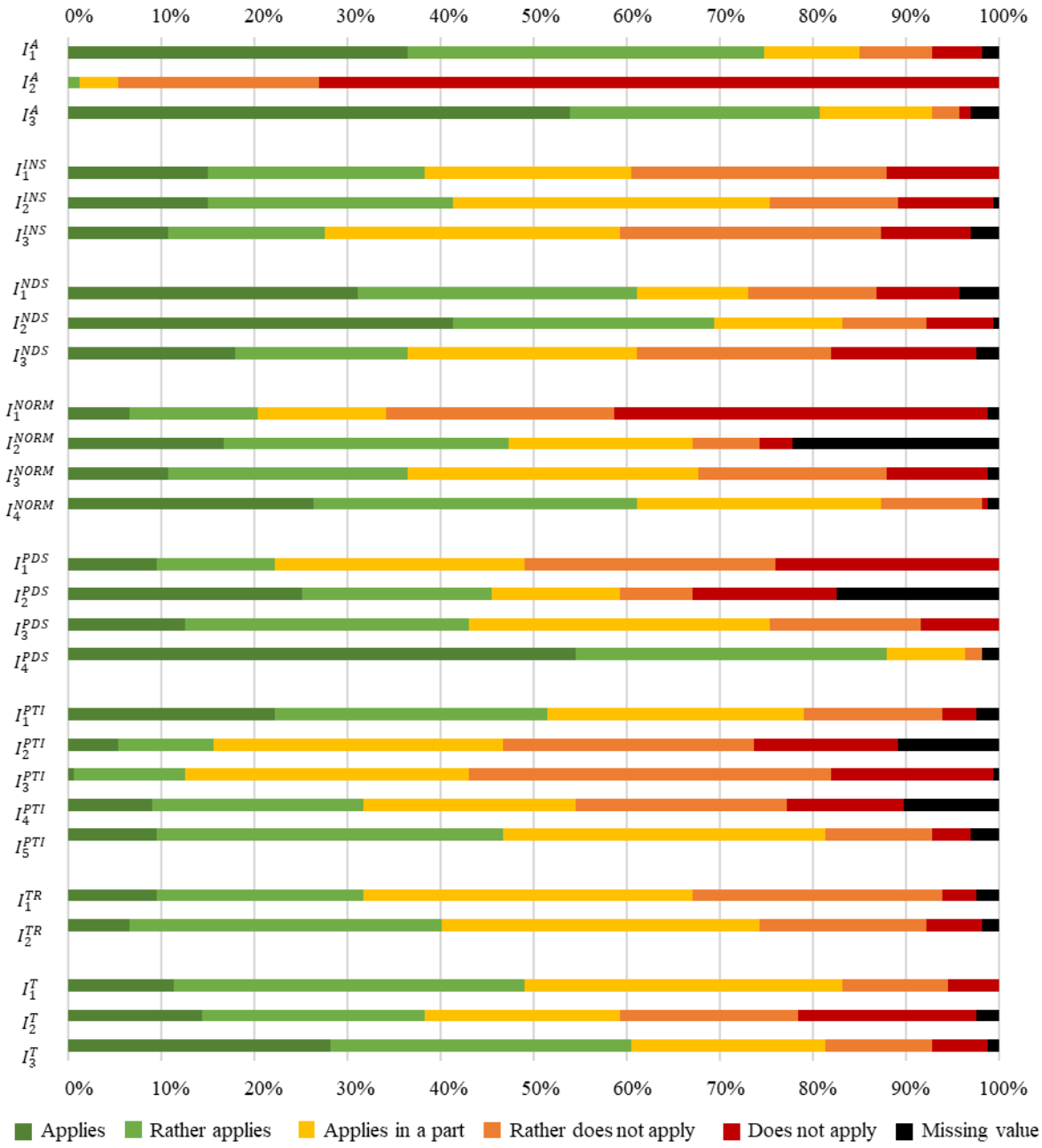

Figure 2. Attitudes towards shopping (online and in-store) and technologies.

The objective of the explorative factor analysis was to verify the suitability and validity of the newly compiled item set in the applied context and to uncover latent variables (LV) in the structure. Further adjustments in form of the exclusion of items of the analysed set were made due to inappropriate MSA-values and communalities for single items. According to MacCallum (*56*) the ratio for the number of variables and extracted factors in relation to the required sample size to generate valid results is still acceptable. As promax-rotation and varimax-rotation led to the same allocation of items to factors varimax-rotation was selected. The results of the common factor analysis are shown in Table 3.

Table 3. Common Factor Analysis (CFA) - Varimax Rotated Factor Pattern

Factors	*Pro-deliveries*	*Technology criticism*	*In-store*
Cronbach´s Alpha	α = 0.66	α = 0.73	α = 0.68
Indicators in CFA			
I_3^{PDS}	0.709		
I_1^{A}	0.561	-0.448	
I_1^{T}	0.546		
I_2^{TR}	0.444		
I_5^{TI}	0.422	0.330	
I_1^{PDS}	0.405		
I_1^{TI}	0.385	-0.319	
I_3^{T}	0.324		
I_4^{N}	-0.537		
I_3^{N}	-0.562		
I_3^{TI}		0.635	
I_2^{A}		0.559	
I_2^{TI}		0.535	
I_4^{TI}		0.522	
I_1^{TR}		0.489	
I_1^{NDS}		0.409	
I_3^{A}	0.358	-0.559	
I_2^{INS}			0.859
I_1^{INS}			0.775
I_2^{NDS}	0.366		0.453
I_3^{NDS}			0.331
I_3^{INS}			-0.703

Printed is the maximum loading of each item

Criteria of extraction and quality for CFA		
Criteria of extraction	*# Factors*	
Kaiser's criterion	3	
Scree-Test	3	
Criteria of quality	*Value*	*Pr > Chi-Square*
Kaiser´s measure of sampling adequacy (MSA)	*0.696 > 0.60*	
Bartlett's test of sphericity	χ^2 (231) = 798.979	p***

N = 118

The factor *pro-deliveries* is primarily determined by a positive attitude towards deliveries. Further, aspects of price and time optimization and the routine in online shopping affect this factor slightly. The ability to navigate the internet, the interest in technological developments and the trust in online retailers are also included. Towards social and personal norms, the personal affinity (mindset) to support local retailers have a negative impact on this factor. The factor *technology criticism* can be traced back to a lack of interest and ability for internet usage as well as a cautious

attitude towards new technologies. The third factor can be described as *in-store* and is determined by the joy of shopping in traditional stores. In addition, aspects such as shipping costs etc. are relevant. Regarding the internal consistency of the factor solution, the values achieved for Cronbach´s Alpha show acceptable values. The factor *technical criticism* is above the limiting value of 0.7 and the factors *pro-deliveries* and *in-store* are slightly below.

In the next step, the LVs identified must be interpreted in the context of individual's travel behavior. The questions arises, whether these LVs are basically suitable to explain the substitution of shopping trips by home deliveries. Basis for this is Figure 3 that illustrates the relationships between the extricated factor values *pro-deliveries* and *in-store* and the number of shopping trips and deliveries over a period of two weeks. Due to the combined consideration of the values of the LVs four quadrants arise. First, two obvious observations are to be mentioned: Persons in the two lower quadrants (preference for deliveries) have larger numbers of deliveries and persons to the left of the ordinate (preference for in-store shopping) make more trips. Second, the detailed view on the quadrants provide the following insights: In the upper left quadrant fewer deliveries than trips can be recognized (the size of the trip bubble overlaps those of deliveries). To some extent respondents did not receive any deliveries at all (no orange bubbles). In contrast, individuals' behavior in the bottom right quadrant show equal numbers of deliveries and trips or a much higher number of deliveries than trips. This coincides with a the high substitution potential suggested for this quadrant, as it is characterized with the combination of a negative attitude towards going shopping and a high affinity for deliveries. In these cases, it can be assumed that the delivery of goods was used as a substitute for personal trips. People with a high preference for shopping as well as for deliveries are positioned in the lower left quadrant. Their behavior demonstrates that they do not travel less for shopping purposes even when goods deliveries are used.

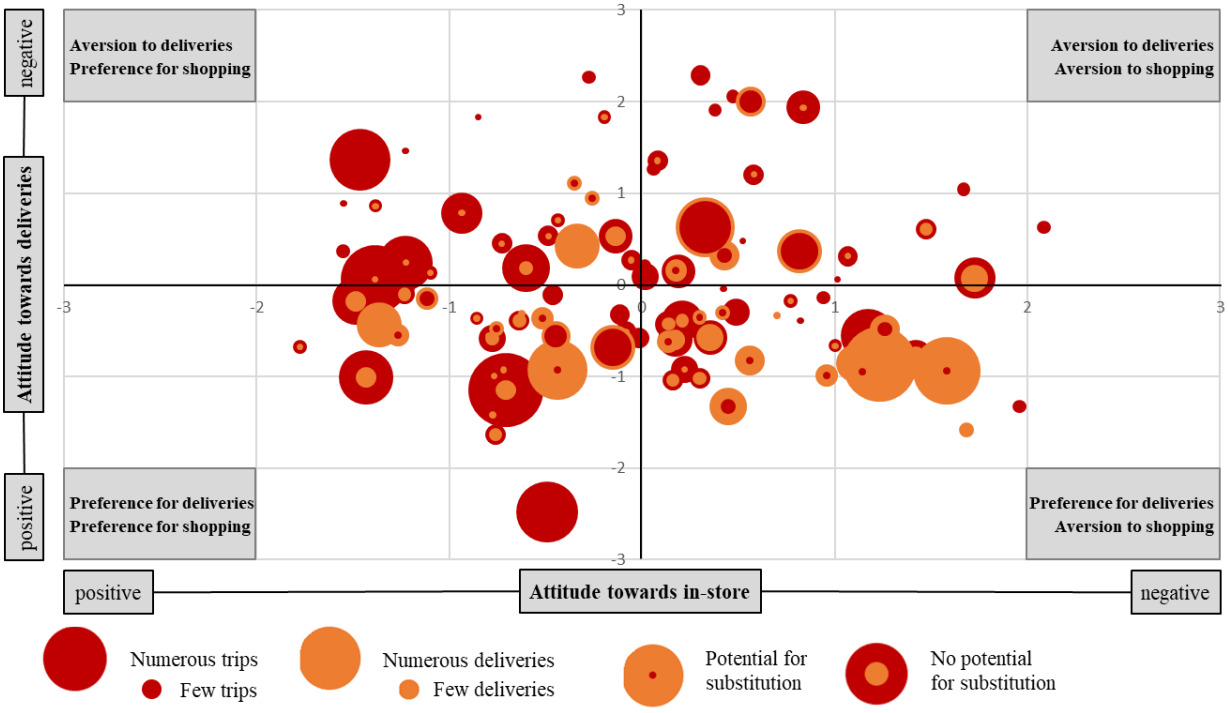

Figure 3. Relationship between attitudes and behavior in terms of shopping trips performed and deliveries received

Furthermore, gender-specific differences can be observed in the enjoyment of shopping represented with the factor *in-store*. Women in this sample generally achieved higher values for this factor than men. They report slightly more trips for leisure shopping purpose than men. In addition, different causes for the receiving of numerous deliveries emerge. While men receive many deliveries because they do not like in-store shopping, women reported high numbers of deliveries relating to a positive attitude towards delivery services. Further descriptive analyses based on socio-demography show that full-time employees and persons aged 36-45, on average receive more deliveries. For employees, it is noticeable that the average value for the factor *pro-deliveries* does not fit together with the high observed number of deliveries. The willingness to use services, in particular third-party delivery services for private transportation purposes, is observable for 11% of the respondents. 32% can partially imagine a delivery service for their individual private use case. It is worth pointing out that car users in particular choose the alternative for being delivered as a conceivable alternative.

Following on from this and including more aspects of travel behavior into the analysis, results showed that for daily car-orientated and multiple users with long commuting distances the average amount of deliveries is higher than for other types of mobility. In this context, it should be briefly mentioned that the daily car-orientated people generally differ from other types in their attitudes and behavior. For example, a spontaneous delivery service at a retailer is a service that half of this group would use. For cyclists, on the other hand, it is irrelevant. The daily car-orientated, in comparison, further indicate higher values for the factor *pro-deliveries*. As a supplementary outcome the significant and positive correlation (0.425, $\chi^2 < 0.0001$) between the factor *car-excitement* and *pro-deliveries* considerably reinforced the visible connection between shopping and travel behavior or car use. Bicycle-oriented people stand out from other mobility

types due to an average more negative attitude towards deliveries, a comparatively lower number of reported deliveries and at the same time an increased number of shopping trips.

With regard to the modes of transport for shopping trips, the developed approach collected information from car owners whether the car was used as a mode of transport for their reported shopping trips. The results show that the car was not used for window-shopping and for small errands and transactions for about three quarters of the respondents who owned a car and reported such an activity. Consequently, this proportion of people used other means of transport for this kind of their shopping travel. The opposite is true for visits to specialist shops. For this purpose, 28 out of 34 persons have indicated that they use the car as their means of transport. The car therefore plays a considerable role in ensuring that specialist shops are reached. With regard to accessibility, the location of shopping opportunities for errands has an influence on the number of trips taken. Persons who can carry out errands within their residential environment report more activities (1.0) than persons who have to move further for this purpose (0.7).

DISCUSSION

In this case, the basic functionality of the questionnaire mainly concerns the duration of the survey. The majority of the participants spent between 21 and 35 minutes processing time. A reduction of the scope of the questions for further applications is basically possible and seems appropriate against this background. Nevertheless, the effort required to complete the survey is acceptable in comparison to trip diaries and in terms of the volume of information that can be generated with this approach. Generally, the results of the previous section prove the applicability of the survey concept and the usability of the data collected. Data significance in this case is mainly limited by the small size of the sample and its characteristic features. However, within the scope of the factor analysis, the necessary sample size has already been proven to be sufficient.

Regarding the latent variables (LV), the literature partly detects both similar and partly different constructs. Attitudes towards shopping in general and the enjoyment of shopping are common factors used to explain shopping behavior (*22, 24, 46*). Similar aspects to the factor *technology criticism* usually fall under points such as risk, trust or ability to use the internet in the factor analyses of other authors (*46, 50, 51*). Considering the great skewness of the I_x^A items and with regard to technological know-how as a relevant requirement for the adaption online shopping results indicate that this technical knowledge is largely available. However, since visible relations can only be recognized to gender-specific aspects, the factor *technology criticism* is only used to a limited extent for the descriptive analysis. First in shopping behavior literature the impact of social norm on shopping attitudes could be demonstrated. Factor loadings regarding the LV *pro-deliveries* show that individuals who consider the support of local traders to be less important, tend to have an affinity to have goods delivered by third-parties.

However, results contain indications that the items referring to two factors partly address different aspects. For example, while the shipping costs in the factor *pro-deliveries* are perceived as disruptive by individuals, they could explain why people prefer to go to shops in the factor *in-store*. Due to these interpretations the slight undercutting of the guideline values for Cronbach´s Alpha is accepted and internal consistency is judged to be given. The recognized trend in this study towards substitution potentials for employees and multimodal individuals with long commute distances contrasts with (*41*), who report fewer online purchases for people with longer working hours. As a high number of deliveries for employees could not be solely related to the factor *pro-*

deliveries, further aspects can and must influence shopping behaviour. Accordingly, the time aspect already considered in the set could gain in importance.

Overall, the results have demonstrated that, in particular, the combined assessment of psychological aspects (LVs *pro-deliveries* and *in-store*) can descriptively explain the observed travel and shopping behavior. For persons with an aversion to deliveries and a simultaneous preference for going shopping no substitution potential is to be expected. On the contrary, visible substitution effects could be accounted for people who dislike going shopping and are positively related to delivery services as well. In the case of preferring shopping in both online and traditional manner, individual travel is complemented by services provided by third parties and is not or only marginally replaced. This assumption coincides with the existing literature (*21*, *22*). The substitution potential can therefore be assessed as limited, especially for people who like to go shopping. Therefore, the factor *in-store* provides an essential indication of individuals' preference to travel for shopping purposes. Further, the findings confirm the role of accessibility for car use. In addition, the correlation of attitude towards cars and the use of delivery services provides an essential element of discussion whether the private car as a means of transport can be replaced by delivery services. This provides evidence that an integrated approach on the basis of a travel behavior framework and including a wide range of psychological aspects leads to promising findings.

CONCLUSIONS

A special aspect of the developed approach in this work is the collection of typical travel behavior with a so-called travel skeleton in combination with an extended set of questions on online shopping behavior and the inclusion of attitudes regarding mode choice, shopping and technology. A questionnaire in this combination was up to now not available in literature. The collected data hold corresponding potential for detailed travel-related evaluations and the investigation of interrelationships with shopping behavior.

In conclusion, factor analysis validated the attitudinal questions and identified three latent variables (LV): *pro-delivery*, *technology criticism* and *in-store* attitudes. This points to interpersonal differences and enables the identification of distinct behavioral and attitudinal groups. For example, the uncovering that the number of deliveries is caused by different LVs dependent on gender enlarges the knowledge of research. Further descriptive results indicate that the ratio of the amount of trips to deliveries within two weeks can partly be traced back to these LVs. The appearance of both substitute and complementary effects can be confirmed in this study, however, these effects are difficult to distinguish and overlap. New findings and added value of this research result from the visibility of the substitution potential when combining the consideration of the factors *pro-deliveries* and *in-store*. It was acknowledged that, in particular, the positive attitude towards shopping in-store can be seen as an essential cause for shopping trips. In the course of this survey, it additionally could be found evidence for a significant connection between the affinity for deliveries, on the one hand, and the enthusiasm for the private car, on the other hand. This corresponds to the hypothesis that passenger car use and the use of delivery services can be related. In contrast, shopping behaviour for cyclists takes place in a nearby environment independent of deliveries.

The explorative data analysis conducted in this research concentrates on whether conclusions in the respect of trip substitution for shopping travel and whether delivery services can partially replace the use and ownership of private cars can be drawn on the basis of the

developed survey approach. Since the first application of this survey approach was able to demonstrate suitable results, further research should be conducted on this basis. The findings obtained in this work therefore represent a first, but surely not a final result. For an advanced examination of the original issue, multivariate methods are required due to their higher explanatory value and contribution to understanding of interactions. Although the item set has attempted to address a variety of aspects, the quality of some individual items is not sufficient to form a separate factor, i.e. feeling of time pressure. Correspondingly to this, the ideas for further extensions and adaptions of the set are diverse. Nevertheless, the presented represents a possibility to generate suitable data for research purposes.

AUTHOR CONTRIBUTION

The authors confirm contribution to the paper as follows: survey concept: Lisa Bönisch, Sascha von Behren, Bastian Chlond; literature review: Lisa Bönisch; data preparation: Lisa Bönisch; data analysis: Lisa Bönisch, Sascha von Behren; interpretation of results: Lisa Bönisch, Sascha von Behren, Bastian Chlond, Peter Vortisch; draft manuscript preparation: Lisa Bönisch. All authors reviewed the results and approved the final version of the manuscript.

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