# Travel modes in grocery shopping

Johan Hagberg[1]* and Ulrika Holmberg[2]

*Corresponding author.

[1] University of Gothenburg; School of Business, Economics and Law; Department of Business Administration; PO Box 610, 405 30 Gothenburg, Sweden. E-mail: johan.hagberg@gu.se, Phone: +46 31 786 14 93, Fax: +46 31 786 46 52.

[2] University of Gothenburg; School of Business, Economics and Law; Department of Business Administration; PO Box 610, 405 30 Gothenburg, Sweden. E-mail: ulrika.holmberg@cfk.gu.se, Phone: +46 31 786 56 06, Fax: +46 31 786 46 52.

Authors accepted manuscript. Accepted for publication in *International Journal of Retail & Distribution Management* 5 April 2017.

Reference: Hagberg, J. and Holmberg, U. (2017), "Travel modes in grocery shopping", International Journal of Retail & Distribution Management, Vol. 45 No. 9, pp. 991-1010. https://doi.org/10.1108/IJRDM-08-2016-0134

## Travel modes in grocery shopping


## Abstract

***Purpose***

Although the movement of goods by consumers represents a large proportion of the economic and environmental impact of the distribution chain, this topic has been insufficiently explored in the retailing literature. This paper's goal is to contribute to the understanding of shopping travel-mode choice in the context of grocery shopping.

***Design/methodology/approach***

The paper presents findings from a Swedish national survey of 1,694 respondents that included questions regarding travel-mode choices and consumer characteristics, mobility conditions, shopping behaviours and environmental interests and engagements.

***Findings***

This paper shows how travel modes interrelate and how various consumer characteristics, shopping behaviours, mobility conditions and environmental interests and engagements relate to and affect travel-mode choice in grocery shopping. General travel patterns and distance to store are shown to be the most important factors in explaining the mode of transport for grocery shopping.

***Originality/value***

This paper presents data from a national representative survey and provides novel analyses of travel-mode choices in grocery shopping and the interrelationships among those choices, in addition to the interrelationship between travel-mode choice and the use of home delivery. This paper contributes to a further understanding of consumer mobility in the context of grocery shopping.



***Keywords***: Retailing, Survey, Transport, Grocery shopping, Consumer mobility, Travel mode, Last mile

***Article classification***: Research paper

**Introduction**

In recent years, research interest in the so-called last mile has resurfaced (Edwards *et al*., 2010; Hübner *et al*., 2016). There has been increased interest in the movement of goods between points of acquisition to points of consumption. This last section of the distribution or supply chain (depending on whether the chain is approached from the perspective of the retailer or that of the consumer) represents a great deal of time, cost and energy in relation to the remainder of the chain (Jespersen, 2004; Browne *et al.,* 2006; Edwards *et al.,* 2010). This topic considers central issues of consumer mobility (e.g., Brembeck *et al*., 2015), consumer logistics in retailing (e.g., Granzin and Bahn, 1989; Granzin, 1990; Granzin *et al.*, 1997, 2005; Bahn *et al*., 2015), and transport research (e.g., Hiselius *et al*., 2015).

Regardless of the research field, the issue of travel-mode choice has become important. With the increased presence of e-commerce (Rotem-Mindali and Weltevreden, 2013), an increased range of sustainability challenges in logistics (McKinnon *et al.*, 2015), and issues surrounding mobility in consumption (Brembeck *et al.*, 2015), there is a practical need to focus more on the topic.

Although there is a large body of work examining shopping trips and shopping that focuses on the distance, frequency, and motives for shopping, this body of research has not accorded sufficient focus to the modes used by consumers to travel to and from stores. Conversely, although there is a large body of work examining transportation, there is a relative paucity of studies investigating either consumers' transport behaviours or the combination of passenger and goods transport that constitutes travel modes in shopping, particularly grocery shopping (Schmöcker *et al*., 2008; Jiao *et al*., 2011; Ding *et al*., 2014; Suel, 2016).

Against this background, there is a need to further explore travel-mode choice in grocery shopping and its antecedents. Thus, this paper's goal is to contribute to the understanding of consumer mobility in the context of grocery shopping by exploring travel-mode choice and how it is affected by various consumer characteristics, mobility conditions, shopping behaviours, and environmental interests and engagements.

The paper is organized as follows: In the next section, we review the previous literature on consumer mobility in grocery shopping and travel-mode choice and outline our research questions. Next, we describe our methods concerning sampling, data collection through a Swedish national mail survey, and exploratory data analysis. The findings are then presented, followed by a discussion of our findings, conclusions and implications for further research.

**Consumer mobility in the context of grocery shopping**

Consumer shopping travels occur at the intersection of shopping and consumption. Whereas studies of consumer behaviour in grocery shopping have focused on the in-store shopping process (see, e.g., Samli *et al.*, 2005; Teller *et al.*, 2012; Bouzaabia *et al.*, 2013), this study will focus on consumer behaviours that occur between the grocery store and the home (or other place of consumption).

The context of grocery shopping is particularly important for several reasons. First, in many countries, groceries represent a large proportion of the goods that consumers acquire and represent a large proportion of retailing sales (OECD, 2017). Second, grocery shopping is a frequent activity, a form of "routine" shopping (Guy, 2009), as groceries largely consist of perishable goods (e.g., Teller *et al.*, 2012; Nilsson *et al.*, 2015). Third, with grocery shopping, consumers are largely involved in conducting various forms of work compared with

shopping for other types of retail goods, with large numbers of self-service stores and self-service delivery from the store (Teller *et al.*, 2012). Despite the intense growth in online grocery retailing and home delivery in recent years, it continues to only represent one or a few percentages of the market share in most countries (SDH, 2016), which means that retail sales in physical stores by far represent the largest proportion of groceries. In addition to online shopping, there has been a proliferation of so-called "click and collect" and "click and drive" (Colla and Lapoule, 2012; Hagberg *et al*., 2016) and other combinations of online and offline retailing; nevertheless, these types of shopping also require consumers to travel to acquire the goods. Accordingly, consumers' shopping travels are a vital part of the flow of goods in the vast majority of purchases. Shopping travels are also an important aspect of general mobility. For example, according to Guy (2009), shopping trips represent approximately 20 per cent of private journeys in the UK. Against this background, grocery shopping and travel modes warrant particular attention.

***Travel modes***

Cars, bicycles, public transport, and walking are the main modes of travel to be analysed in relation to shopping travels. Cars, public transport and walking have traditionally been used in travel-mode studies (e.g., Recker and Stevens, 1976; Limanond *et al*., 2005). Bicycles are an old mode of transport and have been considered less often; however, interest in this mode of travel has garnered new focus (e.g., Ding *et al*., 2014; Hiselius *et al*., 2015), not least because it is viewed as a more environmentally friendly option. Although numerous efforts have been made to promote other modes of transport, in many countries, the *car* continues to be the dominant mode of transport in general (Kent, 2013) for shopping, particularly for grocery shopping (e.g., Dieleman *et al*., 2002; Guy, 2009). Thus,

although the car is a common mode of travel for shopping, many cities are attempting to reduce car dependence and to promote public transport and cycling. The use of cars is challenged when cities attempt to promote sustainability by introducing pedestrian zones, and congestion charging.

*Cycling* is a mode of transport that has been promoted by many municipalities in recent years, and cycling has also garnered ample focus from researchers (see, e.g., Pucher and Buehler, 2008; Buehler and Dill, 2016). However, this body of work has focused relatively minimally on the use of bicycles for shopping purposes (for an exception, see Cochoy *et al.*, 2013). Dieleman *et al.* (2002) found that cycling was more frequently used for shopping than for commuting to work, which they explained via the relatively short distances of these shopping trips. In studies that compare different modes of transport, the proportion of shopping trips involving bicycles is relatively small (e.g., Guy, 2009).

*Public transport* can also be used when shopping. For example, in Singapore, public transport in the form of mass rapid transit (MRT) or bus was the chosen mode of transport for shopping trips approximately 44 per cent of the time; thus, public transport was more common than car travel (Ibrahim, 2003). However, studies from other areas appear to indicate that public transport is a relatively uncommon mode of transport for the purpose of shopping. For example, Dieleman *et al.* (2002) found that public transport was much less frequently used for shopping than for work or leisure. Crowding, which can be particularly troublesome when travelling with groceries, has been noted as one reason for the infrequent use of public transport (Li and Hensher, 2013).

*Walking* is a fourth mode of transport for shopping; this was once the most common mode of transport for grocery shopping before the car became dominant (see, e.g., Hagberg and Normark, 2015 for a historical analysis of consumer logistics in Swedish grocery

shopping). As with cycling, Dieleman *et al.* (2002) found that walking was more frequently used for shopping than for work commutes, which could also be attributed to the relatively short distances of shopping trips. In addition to studies of walking's frequency as a mode of transport to and from stores, studies of pedestrians have focused on their behaviour in shopping areas (e.g., Borgers and Timmermans, 2014) and have specially focused on what pedestrians are carrying (Cochoy *et al.*, 2015; Calvignac and Cochoy, 2015).

In addition to the four travel modes described above, it is important to consider *home delivery*. Whereas home delivery has a long history in grocery retailing in many parts of the world, interest in home delivery has garnered new interest with the increasing use of the Internet for grocery shopping. Studies have also investigated the combinations of Internet and store-based grocery shopping (e.g., Elms *et al*., 2016). Among other things, interest in home delivery has initiated comparisons between home delivery and shopping trips performed by consumers (e.g., Edwards *et al*., 2010). Such comparisons are usually made against the use of cars as a travel mode for grocery shopping (Edwards *et al.,* 2010) but are further complicated by the possible use of other modes of travel (Rotem-Mindali and Weltevreden, 2013).

In addition to cars, bicycles, public transport, and walking as single modes of travel, it is also interesting to explore how these modes are combined. Although such combinations are an important topic in the logistics literature (see, e.g., SteadieSeifi *et al.*, 2014 for a recent review), they have not garnered as much focus in relation to consumers' grocery-shopping trips. It is also interesting to explore the extent to which these modes of travel are combined with home delivery. In considering the combination of home deliveries and travel modes, an increasing number of studies have explored the relationships between various forms of Internet use and travel behaviours (e.g., Cairns, 2005; Rotem-Mindali and

Weltevreden, 2013; Calderwood and Freathy, 2014). Internet behaviours range from Internet use in general (Hjorthol, 2002), Internet use for shopping purposes in general (Hjorthol, 2009; Hiselius *et al*., 2015), and Internet use for grocery shopping in general (Hiselius et al., 2015). Moreover, shopping online may include different aspects of the process, such as searching for information, making the purchase and actual physical delivery (Rotem-Mindali and Weltevreden, 2013). Travel behaviours range from general travel behaviour (Hjorthol, 2002; 2009) to shopping trips (Hiselius *et al*., 2015) to grocery-shopping trips (Hiselius *et al*., 2015). However, in relation to travel modes, the most important aspect is the use of home delivery for groceries. This finding is because, in many countries, it is common to shop for groceries online, although the actual transport of goods continues to be performed by the consumers themselves after pick up at either the store or another collection point. Thus, whereas studies have primarily explored the general use of the Internet and the use of the Internet for general shopping activity and general shopping travels, we are specifically interested in the use of home delivery of groceries and the interrelationships of other modes of travel for groceries. However, as described below, we also include a variable on general buying online.

*Research question 1: a) To what extent are different travel modes used by grocery consumers and b) what are the interrelationships between these travel modes?*

***Socio-demographic characteristics***

Another important aspect concerns differences between consumers based on their behaviours and various socio-demographic characteristics such as age, household size, and income (Limanond *et al*., 2005; Schmöcker *et al*., 2008; Ding *et al*., 2014; Hiselius *et al*., 2015).

Travel mode is of specific interest depending on the availability of different modes of travel in different geographic areas (Hiselius *et al*., 2015). Mode choice has been found to be affected by regional characteristics (Limanond et al., 2005).

The increasing use of the Internet for shopping has called for more comparative research on the extent of Internet shopping and mobility patterns in rural and urban areas (Calderwood and Freathy, 2014). Although it has been proposed that home delivery of groceries instead of private travels are relatively more efficient in rural areas because of those areas' lower density, there may also be a lack of options (Rotem-Mindali and Weltevreden, 2013). Thus, similar to the lower density of grocery stores in rural areas than in urban areas, there also may be a lack of online grocery retailing providers in rural areas (Freathy and Calderwood, 2013).

*Research question 2: How do socio-demographic characteristics affect travel-mode choice?*

***Mobility conditions***

Car ownership or access to a car is a form of mobility condition that has been shown to affect travel-mode choice (Ding *et al*., 2014; Hiselius *et al*., 2015). Dieleman *et al.* (2002) studied travel behaviour with regard to mode of transport and trip purpose, including work, shopping, and leisure. The researchers found that car ownership was the most important variable in terms of mode of transport and concluded that "[i]f people own a car, they use it" (p. 524). In their study of Swedish grocery shoppers, Nilsson *et al.* (2015) included questions about access to a car (which 84 per cent of respondents stated that they had); however, although one of the identified segments (pedestrians) includes those without access to a car, the researchers did not specifically analyse what modes of transport the

consumers used for particular trips. In addition, other mobility conditions may influence grocery travel-mode choice. Thus, we extend the variable of car access into a question of other mobility conditions that are more closely associated with other modes of travel in general and that therefore may affect the modes of travel used for grocery shopping.

*Research question 3: How do mobility conditions affect travel-mode choice?*

***Shopping behaviours***

Travel-mode choice may also be affected by differences in shopping behaviour. Although distance to the store and shopping frequency have been shown to impact travel-mode choice, we also consider two other aspects of shopping behaviour: the purchase of ecological products and the extent to which the respondents purchase products and services online.

One important aspect of grocery shopping is distance to the store (Nilsson *et al.,* 2015). The distance to the store and its importance for other variables have been examined by Hsu *et al.* (2010) in their study of students in a college town in the US Midwest. In a study of Swedish grocery shoppers, Nilsson *et al.* (2015) found that 22 per cent of grocery shoppers lived less than 0.5 km away from their most frequently patronized store; 17 per cent were between 0.5 and 1 km away; and 12 per cent were more than 10 km away. Approximately half of the respondents in Nilsson *et al.*'s (2015) study indicated that grocery-shopping trips were separate trips; slightly more than one-third were connected with work trips, and approximately 15 per cent were connected with other shopping trips or errands.

Another important aspect is the frequency of shopping (Rotem-Mindali and Weltevreden, 2013; Nilsson *et al*., 2015; Suel, 2016). In Hsu *et al.*'s (2010) study of college students, approximately a third shopped for groceries once a week, but a higher frequency

can be expected in other consumer groups. A general shopping distinction can be made between major and fill-in shopping trips (see, e.g., Kahn and Schmittlein, 1989; Walters and Jamil, 2003; Nilsson *et al.*, 2015). In their study of Swedish grocery shoppers, Nilsson *et al.* (2015) found that approximately 3 per cent bought less frequently than once per week; 17 per cent bought once per week, and 80 per cent bought more than once per week. Frequency can be related to shopping travel mode by differences in shoppers' ability to carry things (Suel, 2016). Jiao et al. (2016) found that infrequent shoppers were more likely to drive longer distances.

Because different modes of travel may be considered as having more or less impact on the environment (Edwards *et al.,* 2010), it is also interesting to consider the choice of travel mode in relation to purchase behaviour related to environmental aspects. Specifically, we are interested in exploring how the purchase of eco-labelled food is related to travel-mode choice.

As noted above, although we consider home delivery of groceries as the most relevant aspect of Internet shopping to consider in relation to travel modes for grocery shopping, it is also interesting to consider the relationship between general Internet shopping and travel modes for grocery shopping. Hiselius *et al.* (2015) found that people who make frequent, regular purchases online made more trips by modes other than car (by bicycle, foot and public transport) than people who did not make frequent, regular purchases online; whereas for car use, there were few differences.

*Research question 4: How do grocery-shopping behaviours (distance to most frequented store, purchase frequency, eco-buying and general buying online) affect travel-mode choice?*

### *Environmental interest and engagements*

As noted above, the use of travel mode for grocery-shopping purposes has a substantial environmental impact related to the different modes of travel employed (e.g., Edwards *et al.,* 2010). In addition to the questions above, we are also interested in whether respondents' environmental interests and engagements affect their choice of travel mode.

*Research question 5: How do environmental interests and engagements affect travel-mode choice?*

## Methods and materials

### *Study design and data collection*

The above reviewed literature is the result of a combination of focus on specific contexts with efforts to synthesise and gain insights that may be useful beyond these contexts. Previous research has been conducted in different geographical areas on both the national and city level in larger and smaller countries, such as: the UK (Cairns, 2005; Guy, 2009; Edwards *et al.*, 2010), Scotland (Calderwood and Freathy, 2014), London, UK (Schmöker *et al*., 2008; Suel, 2016), The Netherlands (Dieleman *et al*., 2002), Maryland-Washington DC, US (Ding *et al.*, 2014), Midwestern college town, US (Walters and Jamil, 2003; Hsu *et al.*, 2010), Seattle, US (Limanond *et al.*, 2005; Jiao *et al*., 2011, 2016), Sydney, Australia (Kent, 2013), and Sweden (Hiselius *et al.*, 2015; Nilsson *et al.*, 2015). Thus, to explore travel modes in grocery shopping, we explore a specific context but also with the objective to gain insights that may also be more generally relevant. This objective requires

sensitivity to the context in which the study is performed and the particular aspects that may be different or similar to other contexts.

The study has been conducted at the national level in Sweden, a north European country with approximately 10 million inhabitants. The country has a relative low density with 24 inhabitants per square kilometre of land area (World Bank, 2016a). Of the population, 86 per cent is urban, which is similar to the proportion in the US (82%) and slightly higher than the average for the European Union (75%) and OECD members (80%) (World Bank, 2016b).

As in many other European countries, the grocery retail market in Sweden is highly concentrated with a few large national retailer chains (Einarsson, 2008; Burt, 2010; Hultman and Elg, 2013). As in other developed countries, these chains include different store formats, and the Swedish grocery retail market consists of a mixture of hypermarkets, large supermarkets, traditional supermarkets and convenience stores (Einarsson, 2008; Burt, 2010; Nielsen, 2015). Online grocery shopping in Sweden in 2015 was estimated to be 1.5 per cent (SDH, 2016), which is similar to the market share for online groceries in the US (1.4%) and European countries such as Germany (1.2%), Denmark (1.3%), the Netherlands (1.7%) and Spain (1.7%), higher than in European countries such as Italy (0.4%) and Portugal (1%) and South American countries such as Brazil (0.1%) and Argentina (1%), but significantly smaller than European countries such as the UK (6.9%), France (5.3%) and Asian countries such as South Korea (16.6%), Japan (7.2%) and China (4.2%) (Kantar, 2016).

The modal split of passenger transport in Sweden is similar to the average for the European Union with 8.9 per cent proportion for trains (7.6% for EU28), 84.7 per cent proportion for passenger cars (83.4% for EU28) and 6.4 per cent motor coaches, buses and trolley buses (9.1% for EU28) (Eurostat, 2016). The largest deviation is for the third category,

where there is a large variation between different European countries. However, what will also be further highlighted in this study is that there is also a great variation of travel modes within the national context. Moreover, as indicated above, this study, which concerns travel modes for grocery shopping, will consider other modes of travel, such as bicycling and walking by foot. In sum, Sweden has certain characteristics that should be considered; however, there are also many similarities with other countries regarding national characteristics, grocery shopping and travel modes.

The study was conducted with a large national mail survey, which was sent to a representative sample of 3400 Swedish households in the fall of 2014. The respondents could choose to answer the questionnaire by mail or online using the login data provided in the enclosed letter. In total, 1694 respondents completed the questionnaire, which provided a net response rate of 53 per cent. The survey, which was administered by the SOM Institute at the University of Gothenburg, includes a set of questions on broad topics within the social sciences, including media consumption, political opinions, mundane activities, and consumption. The SOM survey is renowned for its high representativity of the Swedish population, although there are limitations related to the number of questions that can be included for each topic. As such, this study has been limited to a small set of variables, thus generating a high response level. The non-response analysis of the survey shows that men and young people exit somewhat more often, which is why women and the elderly are moderately overrepresented among those who completed the questionnaires. As such, women represent 55 per cent of the respondents compared with 50 per cent of the population; 16–29-year-olds represent 14 percent of the respondents compared with 22 per cent of the population; and 50–75 years olds represent 50 per cent of the respondents compared with 39 per cent of the population.

***Measures and scales***

The paper includes variables adapted to the study of choice of travel mode in grocery shopping in combination with common variables used in the questionnaire and shared with other researchers. The dependent variables are the frequency of use of the five modes of transport: car, bicycles, public transport, walking and home delivery. The independent variables discussed in this paper cover four main areas: socio-demographic characteristics, mobility conditions, shopping behaviours, and interest and engagement in environmental issues.

The questions about mode of transport for grocery shopping and three of the shopping-behaviour variables, frequency of purchases in food stores, frequency of purchasing eco-labelled food, and distance to the main food store, were found under the "Consumption" heading in the questionnaire. The fourth shopping-behaviour variable, frequency of buying goods and services online, belonged to the section "Internet and Mobile Phone". The frequency scales measure annual averages, in accordance with the other questions about frequency in the survey[1]. The specific questions were as follows:

1. How often, during the last 12 months, did you get to the store in the following ways when buying groceries? The question applies to both major purchases and fill-in purchases of a few items.
    - Bicycle
    - Car

[1] Seven-point scales. For grocery shopping, the alternatives were never, sometime in the last 12 months, sometime in the last six months, sometime in the last three months, sometime in the last month, sometime in the last week, or several times per week. For Internet shopping, the alternatives were never, sometime in the last 12 months, sometime in the last six months, sometime in the last month, sometime in the last week, several times per week, or daily.

- Public transport
- By foot
- Home delivery

2. How often, during the last 12 months, did you buy any of the following?
    - Food for your household
    - Eco-labelled food
3. How far is your home from the store where you most often buy your food? (5-point scale: Less than 1 km, 1-2 km, 3-5 km, 6-10 km, More than 10 km).
4. How often, during the last 12 months, did you do any of the following?
    - Buy/order goods or services

The socio-demographic, mobility, and environmental-engagement variables all belong to the common part of the questionnaire, which provides participating researchers with an array of background data. The socio-demographic characteristics category thus includes age, gender, duration of school education, type of household (marital status, number of household members, and number of children), residential context (urban/rural), and income (personal and household income). The mobility conditions category includes access to a car in the household, the frequency of use of various modes of transport in everyday life (driving a car, travelling by public transport, and cycling), and the frequency of being in nature (as an indication of walking habits). The category of interest and engagement in environmental issues encompasses membership in an environmental organization, perceived anxiety about environmental pollution, and perceived anxiety about climate change.

***Data preparation and analysis***

In the process of cleaning the data, we have applied a restrictive interpretation in terms of what answers to regard as missing. All types of missing data are coded as missing. In multiple response questions, such as our question about modes of transport, some respondents tended not to answer questions about items that they never use, although they were provided with the choice "never". Nevertheless, because we cannot be sure of the reasons for not answering, we refrained from recoding internal non-responses.

The data analysis conducted includes descriptive statistics, bivariate correlations, and stepwise multiple-linear regression. Bivariate analyses include crosstabs with chi-square tests for independence, Spearman rank correlations, and variance analysis (one-way ANOVA). The level of significance is shown at the 1 per cent and the 5 per cent levels. Any association with a p-value higher than 5 per cent is regarded as non-significant. Because of the large sample size, weak correlations pass the 1 per cent level of significance. The reason behind the inclusion of low magnitudes is the nature of the variables. As in many other studies of human behaviour, it is unlikely that only a few variables represent the majority of the variance in the dependent variable. Instead, one can easily imagine a wide array of possible explanations and associations, each contributing a small proportion of the variance. To provide for a discussion of which background variables are most important in explaining the frequency of mode of transport, we have included multivariate analyses. We tested all of the socio-demographic, mobility, shopping-behaviour, and environmental-engagement variables mentioned above, provided the correlation was significant and the magnitude at least 0.1, as possible independent variables in stepwise multiple-linear-regression analyses. The results should be interpreted carefully. The variables involved are mostly ordinal scales,

and some of the explanatory variables are correlated. To decrease problems of collinearity, we excluded some of background variables. Because of the use of cross-sectional data, we cannot conclude what is a cause and what is an effect. However, in certain cases, it is highly unlikely that we are addressing two-way correlations or inverse causal relationships, e.g., age, education, and income will affect choice of travel mode, not vice versa.

**Findings**

The findings are described in six subsections. First, we present the analyses of travel modes and their interrelationships. This presentation is followed by four sections in which we analyse the relationships between travel-mode choice and socio-demographic characteristics, mobility conditions, shopping behaviour, and environmental interests and engagements. In the final section, we present a stepwise linear multiple regression analysis of the included variables in relation to each of the travel modes explored.

***Modes of transport***

Compared with walking, cycling, public transport, or home delivery, the car is by far the most dominant mode of transport when consumers buy food, as presented in Table I. More than 70 per cent of consumers travel by car at least once a week when they buy groceries. Only a small percentage of the respondents (10 per cent) stated that they never use a car. The second most common mode of transport to and from the store is walking; 42 per cent of respondents stated that they walk to the store at least once a week. Cycling and public transport are far less common among respondents, with a fifth of respondents saying that they use their bike at least once a week, and less than a tenth saying that they use public transport for this purpose. Although home delivery has a long history in grocery shopping

and has received a new boost with online shopping (Hagberg and Normark, 2015), the proportion of consumers who use this service for grocery shopping is small. Only 8 per cent of respondents use home delivery at least occasionally, which indicates that home delivery is not a substitute but a complement to grocery shopping in physical stores. This indication is supported by statistics on online grocery shopping, which represents approximately 1.5 per cent of total grocery sales in Sweden (SDH, 2016).

[Please insert Table I about here]

Many consumers do not use a single mode of transport; instead, they tend to combine different modes of transport. Table II shows how, on the one hand, consumers who cycle or use public transport also walk to the store and vice versa. Car users, on the other hand, do not use other modes of transport very often. The consumers who use home delivery also use public transport to the store. The correlations between driving, on the one hand, and walking, using public transport, or cycling, on the other hand, are significantly negative, particularly with regard to walking and driving.

[Please insert Table II about here]

The use of multiple modes of transport can be attributed to two forms of behaviour. First, different modes of transport could be chosen for different trips. Second, different modes of transport could be combined during the same trip. Analysing when and how multiple modes of transport are combined is an important avenue for future research. However, certain preliminary conclusions can be currently derived. Walking and public transport are likely combined during the same trip, while cycling and walking probably occur

for different trips. Regardless, the results for driving seem to indicate that it is very seldom combined with other modes of transport, whether during the same trip or for different trips.

***Socio-demographic characteristics***

Place of residence demonstrates the strongest correlations to grocery store travel mode among the studied socio-demographic characteristics. As shown in Table III, the correlations between modes of travel and age, gender, education, income, employment, place of residence, marital status, and type of household differ significantly among the transport modes. For the car alternative, the strongest correlations are place of residence, type of household, marital status, household and personal income. People living in rural areas, living together as cohabitants or married and with high incomes more often use a car to go to the grocery store. The correlations are generally weaker for the bicycle alternative. Urban living, lower education and young age are correlated to higher frequencies of biking to the grocery store. Public transport and walking are the most correlated to place of residence, marital status, household type and age, where urban areas, singlehood and young age means that public transport and walking is used more frequently. Age, income and place of residence are the strongest correlations to home delivery, meaning that young people with higher incomes and living in urban areas choose home delivery more often.

[Please insert Table III about here]

Our findings indicate that consumers' places of residence in urban or rural settings require further focus. In larger cities (more than 0.5 million residents), walking to the

grocery store is the most common mode of transport, whereas in small cities and towns as well as in rural areas, the car dominates. In large cities, we find that 74 per cent walk, 45 per cent go by car, 24 per cent use public transport, 18 per cent ride a bicycle, and 3 per cent choose home delivery one or several times per week. In the countryside, as much as 87 per cent travel by car, 8 per cent walk, 6 per cent bicycle, and 1 per cent use public transport one or more times per week. In the countryside, home delivery only occurs occasionally, which indicates an availability dilemma for home delivery (cf. Freathy and Calderwood, 2013), further discussed below.

***Mobility conditions***

Unsurprisingly, the frequency of car use for grocery shopping is strongly correlated to car access and how often consumers drive in general (i.e., for other purposes, such as commuting to work). Correspondingly, car use for grocery shopping is negatively correlated to everyday travel via public transport and cycling. Thus, as Dieleman *et al.* (2002, pp. 524) noted, "[i]f people own a car, they use it", including for grocery shopping. Eighty-five per cent of the respondents have access to a car, which is in accordance with Nilsson *et al*. (2015). The analysis of mobility conditions further shows that there is a weak but significant negative correlation between car use when buying food and the frequency of being in nature.

***Shopping behaviour***

Grocery shopping is a frequent activity. Our results show that more than 90 per cent of consumers buy food for the household at least once a week. Nearly two-thirds of consumers buy food several times a week. Thirty per cent of consumers are less than 1 km

away from the store where they most often buy their food and, together with consumers that are 1–2 km away, they constitute more than half of consumers. Approximately one-third of consumers are 3–10 km away from their most frequently visited store, while consumers who are more than 10 km away from their store represent 13 per cent of the respondents. Although shorter distances indicate more frequent trips to the store than longer distances, it is worth noting that several times a week is the most common frequency regardless of the distance to the store. The frequency of grocery shopping, together with the distance to the most frequently visited store, indicates that the consumer logistics associated with grocery shopping generates ample mobility needs and transport demand.

Using a car as mode of transport is correlated with frequency and distance, as shown in Table III. Frequent car users travel a longer distance to the grocery store, which is no surprise. These users also buy groceries more often than the average consumer, which warrants further attention. On the one hand, consumers who use the car for shopping likely go to the store more frequently because of a larger total volume of groceries and a tendency to combine major trips and fill-in trips during the week (cf. Nilsson *et al.*, 2015). On the other hand, cars have a high loading capacity than other modes of transport, meaning that more goods can be loaded on each shopping trip, which could lead to fewer trips to the store (cf. Suel, 2016). However, the results do not indicate that a car's superior loading capacity reduces the shopping frequency. Grocery shopping by car on the way home (from work) also makes it easy to stop by for small purchases.

***Environmental interests and engagements***

Despite the environmental impacts of car use, consumers' car use for grocery shopping does not appear to be linked to their environmental concerns. None of the

indicators of environmental interests and concerns in Table III is significantly correlated to the frequency of car use for grocery shopping. Instead, environmental concerns are significantly related to the frequency of walking, cycling and public transport use when buying groceries. This finding may indicate that environmentally engaged consumers exclude the car from their environmentally friendly ambitions not because they do not recognize the emission bur rather that other factors becomes more important in the choice between different travel modes.

***Main predictors of travel mode for grocery shopping***

General travel patterns and distance to the store are the most important factors in explaining the choice of transport mode for grocery shopping, except for the choice of home delivery, when looking at multivariate analyses. Table IV shows the result of stepwise multiple-linear regressions for each mode of transport. To minimize the problem of high correlation between the explanatory factors, we attempted different combinations of independent variables from Table III. Few socio-demographic variables add to the prediction of grocery store travel modes. Place of residence, household income and/or marital status are included among the predictors for public transport, walking and home delivery. The purchase of eco-labelled food joins biking and walking to the store as a predictor on the margin.

The frequency of choosing the *car* is best predicted by travel patterns and distance to store only. Car trips to the grocery store are more common the more often consumers use the car in general, the longer the distance to the store and the less they use bicycle and public transport for other trips. Together, these four predictors represent nearly 40 per cent of the variation in the frequency of choosing the car to the grocery store. The probability of

using the *bicycle* to the grocery store increases the more consumers cycle every day; the shorter the distance to the store, the less they travel by car in general and the more frequent they buy eco-labelled food. These predictors explain as much as 60 per cent. The chances of choosing *public transport* to the grocery store increases the more often consumers also use this mode of transport in everyday life, the less often they travel by car, the lower the household income, the more urban their place of residence, the shorter the distance to the store, and the greater the likelihood of living as single or cohabitant rather than being married or widow/er. The likelihood of *walking* to the grocery store is greater when consumers live close by the store, often travel by public transport, live in an urban setting, live as single or cohabitant, seldom travel by car, and often buy eco-labelled food.

[Please insert Table IV about here]

It is interesting to note that the most important explanatory factors for choosing *home delivery* are the frequency of buying goods and services via Internet, household income and place of residence. The more often consumers buy online, the higher the income and the more urban they live, the higher the chance they will use home delivery. Because of the limited number of respondents choosing home delivery, only a small part of the variance is explained.

**Concluding discussion**

The purpose of this paper was to contribute to the understanding of consumer mobility in the context of grocery shopping by exploring travel-mode choice and how it is affected by various consumer characteristics, mobility conditions, shopping behaviours, and

environmental interests and engagements. Consumer mobility is an important aspect for the understanding of grocery shopping and vice versa, as much of contemporary grocery shopping requires consumer mobility, whereas a large proportion of households' mobility consists of transport to and from the grocery stores.

The study has shown that the car is the dominant mode of transport for groceries in Sweden, which is in accordance with other studies in other geographical contexts (e.g., Dieleman *et al*., 2002; Guy, 2009). The use of the car as the most common mode of travel is followed by walking, bicycling and public transport, in that order of importance. Other studies have shown similar results, although other modes than the car have been aggregated in the same category (Ding *et al*., 2014; Hiselius *et al*., 2015). A minor portion of the respondents in this study reported the use of home delivery. Consumers also combine different modes of travel for grocery shopping. However, this combination is the case with bicycles, public transport and walking, whereas the use of the car is negatively correlated with the other modes of travel. The only significant relationship between the use of home delivery and other modes of travel was a weak correlation to public transport.

Among the socio-demographic characteristics examined, place of residence was found to be the most important (cf. Limanond *et al*., 2005; Calderwood and Freathy, 2014). This finding further underscores the importance of paying attention to different geographical contexts within a country, as infrastructure for transport and retail services differ very substantially between urban and rural areas. Other important characteristics are age, the type of household and household income, which is in accordance with other studies (e.g., Schmöcker *et al*., 2008; Ding *et al*., 2014; Hiselius *et al*. 2015). However, there are major differences among various modes of travel in terms of what characteristics are particularly important.

The different mobility conditions were found to highly influence the use of travel modes. Similar to what has been found in other studies, access to a car and the frequency of car use for other purposes is strongly correlated with the use of the car for grocery shopping (e.g., Ding *et al*., 2014; Hiselius *et al*., 2015). As expected, however, we also found strong correlations for the equivalent comparison with bicycles and public transport. This study shows that mobility conditions related to the car (access, frequency of use) often used in studies of travel-mode choice should correspondingly be extended with mobility conditions related to other modes of travel.

Distance and frequency were strongly related to the use of the car as a travel mode for grocery-shopping trips. However, both the frequency of eco-labelled food purchases and the frequency of overall purchases of goods and services via the Internet were shown to have weak relationships with the use of different travel modes for grocery shopping, with the exception of the relationship between the latter and home delivery, which is no surprise.

Environmental interests and engagements were found to have minimal effect on the use of various travel modes for grocery shopping. Given the different environmental impacts of the use of different travel modes, this may be slightly puzzling, although when other aspects such as place of residence, access to and use of different travel modes for other purposes are included in the picture, considerations of environmental interests and engagements recede. Personal convenience and a car-prone culture also play a part in promoting the car choice. Altogether, this finding means that encouraging environmental interests will not solve the problem of car dependency. Instead, policy should be directed at infrastructure, making more environmentally friendly transport alternatives easily accessible to more people in their daily activities including grocery shopping.

Based on a national survey, our findings primarily concern the context of Sweden. However, as further described in our method section, consumer mobility in grocery shopping have many common features in other national contexts concerning density, differences between urban and rural areas, modal splits, retail structure, a small but rapidly growing proportion of online shopping. Thus, this study also provides insights relevant for other geographical contexts as well as for the research on consumer mobility more generally. The study complements and contributes to this literature in three main ways.

First, this study contributes with a consideration of the interrelationships between different modes of travel including home delivery. In addition to the study of relationships between home delivery and modes of travel for grocery shopping, this study contributes with insights in the combination of different modes of travel. It is important to understand not only how these are related but also how home delivery is related to other travel modes than the car because this will influence the possible environmental effects depending on what modes of travel that are replaced (cf. Edwards *et al*., 2010; Rotem-Mindali and Weltewreden, 2013).

Second, the importance of the place of residence for all of the travel modes is particularly important and points towards an availability dilemma regarding home delivery service (cf. Freathy and Calderwood, 2013). As noted in the previous point, the environmental effects of home delivery are dependent on what travel modes it replaces (Edwards *et al*., 2010; Rotem-Mindali and Weltewreden, 2013). The dilemma is that online shopping and home delivery is more available in urban areas, but it is also in these areas where we observe a larger extent of other travel modes than the car, i.e., walking, bicycling and public transport. These options are enabled by an availability of transport infrastructure together with availability of grocery stores. If urban consumers begin buying more groceries

online with home delivery, there is an apparent risk that they will replace travel modes with lower environmental impact, such as walking, bicycling, and public transport, that they otherwise would use, which then adds to rather than reduces the environmental impact. At the same time, in more sparsely populated areas, the car continues to be used for grocery shopping trips due to a lack of availability of home delivery for perishable groceries.

Third, this study highlights the need to move from general questions about online shopping in favour of more specific questions that concern the movement of goods. Although online shopping is likely to increase in coming years, a large proportion of grocery shopping online is in the form of so-called "click and collect" or "drive through" (Colla and Lapoule, 2012), meaning that consumers must still actually transport the goods from the store and to the home or other point of consumption. This further underscores the importance to study specifically the use of home delivery for grocery shopping as a complement to the more general questions of online shopping as there may be a division of for example the ordering and payment of the goods and the physical delivery which could be arranged in different combinations of online and offline (cf. Hagberg *et al*., 2016). This further underscores the need to complement questions about online shopping with the specific question about home delivery.

In sum, this paper contributes with a better understanding of consumer mobility in grocery shopping concerning the travel modes used and what influences the use of these modes. The paper specifically contributes to the previous literature on consumer mobility concerning interrelationships between different travel modes including home delivery, an availability dilemma of travel-mode choice and the separation of home delivery as a particular important aspect of online shopping in the understanding of consumer mobility.

***Research limitations and future research***

Although several more general conclusions can be drawn, this study has been conducted in the context of grocery shopping in Sweden, which constitutes a limitation. However, as shown above, there are also several similarities to other countries regarding retail development and general travel patterns. Many of the findings on consumer mobility can be expected to be similar in other national contexts with similar density, urban population, modal splits, grocery retail structure and proportion of online shopping. However, and despite that many issues are shared among different contexts, there is also a need for contextual sensitivity as well as comparisons of how such aspects change over time. The scope of study is restricted to a limited set of variables to allow for an analysis of a larger number of respondents. This study complements more qualitative studies on this topic, but it is restricted to a narrower set of data per respondent.

There are three main opportunities for future research in this area. First and foremost, we believe that the analysis conducted in the Swedish context can be complemented by similar studies in other geographical areas to compare these different contexts in more detail. Given the relatively high frequency of grocery shopping as an integrated aspect of everyday life, it warrants further research from a variety of perspectives, such as consumption, retail management, and transportation. In the field of transportation, we believe that today's relatively divided focus on passenger transport, on the one hand, and freight transport, on the other hand, may benefit from integration in exploring consumer shopping travels. In retailing, a potential avenue for future research involves studying shopping mobility from an activity-based perspective in line with Nijland *et al.* (2013). This work would also benefit from the continued use of different methods that are complementary and may be used to explore and further investigate this topic. Many

countries and regions are today confronting similar issues regarding consumer mobility, e.g., in terms of sustainability challenges, increasing online shopping and growing differences between urban and rural areas. It is important to be sensitive to the specific context in which the studies are conducted but also make it possible to gain insights and make comparisons between different contexts.

Second, the study has explored aggregated behaviours starting with individuals and with the goal of identifying combinations. This approach could be fruitfully extended through studies that use individual shopping trips as the starting point to determine how different travel modes are used and combined by each individual, considering other contextual factors such as time and place considerations for a single trip. A better understanding of how and why requires both qualitative and quantitative studies. Qualitative in-depth studies of consumers' daily lives can be utilized to find new contextual explanations, while quantitative studies can be used to estimate relationships and effects and providing ground for international comparisons.

Third, home delivery of groceries is a growing phenomenon both in Sweden and in many other parts of the world. This study has been performed at an early stage of this development in Sweden (as it seems) and therefore can (nearly) be used as a "point zero" for comparison in future studies that analyse the effects of home delivery on travel-mode choice in grocery shopping. As discussed above, it is important that analyses of general online shopping or grocery online shopping are complemented with specific questions regarding how the goods are transported. Innovations at the intersection of physical and online retailing such as "click and collect" are important drivers of an increasing use of online shopping but, regarding the distribution of the goods, many of these solutions continue to require the consumer to do the actual transport.

***Practical implications***

Consumer shopping trips are a resource-consuming activity in terms of time, costs and environmental impact. Our findings suggest that retailers should focus more on their customers' shopping-related activities. For example, retailers may promote modes of travel other than the car, for example, by providing bike stands/shelters for bike carts that are close to entrances and collaborating with traffic planners for access to bike lanes and public transportation. Retailers may also provide other forms of services that help transform some of the shopping trips performed by consumers into business opportunities, for example, by emphasizing home delivery services, which may also involve other customers providing services to one another.

On the basis of the findings with major differences between urban and more sparsely populated areas the provision of such alternatives may vary greatly between different places. For example, in urban areas, retailers may rely more on the existing infrastructure and primarily focus on interconnections to that infrastructure, e.g., concerning the facilitation of bicycle, walking and public transport. In more rural areas, it may be a matter of active engagement in providing such infrastructure, for example by providing shuttle services for customers to travel between the store and the home or by establishing points of consolidation between the stores and consumers' homes.

**References**

Bahn, K.D., Granzin, K.L. and Tokman, M. (2015), "End-user contribution to logistics value co-creation: A series of exploratory studies", *Journal of Marketing Channels*, Vol. 22 No. 1, pp. 3–26. doi:10.1080/1046669X.2015.978694.

Borgers, A. and Timmermans, H. (2014), "Indices of pedestrian behavior in shopping areas", *Procedia Environmental Sciences*, Vol. 22, pp. 366–379. doi:10.1016/j.proenv.2014.11.034.

Bouzaabia, O., van Riel, A.C.R. and Semeijn, J. (2013), "Managing in-store logistics: a fresh perspective on retail service", *Journal of Service Management*, Vol. 24 No. 2, pp. 112–129. doi:10.1108/09564231311323926.

Brembeck, H., Cochoy, F. and Moisander, J. (2015), "Moving consumption", *Consumption Markets & Culture*, Vol. 18 No. 1, pp. 1–9. doi:10.1080/10253866.2014.899218.

Browne, M., Allen, J. and Rizet, C. (2006), "Assessing transport energy consumption in two product supply chains", *International Journal of Logistics: Research and Applications*, Vol. 9 No. 3, pp. 237-52. doi:10.1080/13675560600859243.

Buehler, R. and Dill, J. (2016), "Bikeway networks: a review of effects on cycling", *Transport Reviews*, Vol. 36 No. 1, pp. 9–27. doi:10.1080/01441647.2015.1069908.

Burt, S. (2010), "Retailing in Europe: 20 years on", *The International Review of Retail, Distribution and Consumer Research*, Vol. 20 No. 1, pp. 9–27. doi:10.1080/09593960903497773.

Cairns, S. (2005), "Delivering supermarket shopping: more or less traffic?" *Transport Reviews*, Vol. 25 No. 1, 51–84. doi:10.1080/0144164042000218391.

Calderwood, E. and Freathy, P. (2014), "Consumer mobility in the Scottish isles: The impact of internet adoption upon retail travel patterns", *Transportation Research Part A: Policy and Practice*, Vol. 59, pp. 192–203. doi:10.1016/j.tra.2013.11.012.

Calvignac, C. and Cochoy, F. (2015), "From 'market agencements' to 'vehicular agencies': insights from the quantitative observation of consumer logistics", *Consumption Markets & Culture*, Vol. 19 No. 1, 133–147. doi: 10.1080/10253866.2015.1067617.

Cochoy, F., Ducourant, H., Calvignac, C., Canu, R., Hagberg, J. and Normark, D. (2013), "'Funny bikes': a Comparative/Quantitative Video Analysis of Biker Logistics (Göteborg and Toulouse)", InMobility Futures, Global Conference in Lancaster, UK, 4-6 September 2013, Lancaster University, UK.

Cochoy, F., Hagberg, J. and Canu, R. (2015), "The forgotten role of pedestrian transportation in urban life: insights from a visual comparative archaeology (*Gothenburg and Toulouse*, 1875-2011)", *Urban Studies*, Vol. 52 No. 12, pp. 2267–2286.

Colla, E. and Lapoule, P. (2012), "E-commerce: exploring the critical success factors", *International Journal of Retail & Distribution Management*, Vol. 40 No. 11, pp. 842–864. doi:10.1108/09590551211267601.

Dieleman, F., Dijst, M. and Burghouwt, G. (2002), "Urban form and travel behaviour: micro-level household attributed and residential context", *Urban Studies*, Vol. 39 No. 3, pp. 507–527. doi:10.1080/00420980220112801.

Ding, C., Xie, B., Wang, Y., & Lin, Y. (2014), "Modeling the joint choice decisions on urban shopping destination and travel-to-shop mode: A comparative study of different structures", *Discrete Dynamics in Nature and Society*. doi:10.1155/2014/492307.

Edwards, J.B., McKinnon, A.C. and Cullinane, S.L. (2010), "Comparative analysis of the carbon footprints of conventional and online retailing: A 'last mile' perspective",

*International Journal of Physical Distribution & Logistics Management*, Vol. 40 No. 1/2, pp. 103–123. doi:10.1108/09600031011018055.

Einarsson, Á. (2008), "The retail sector in the Nordic countries: A description of the differences, similarities, and uniqueness in the global market", *Journal of Retailing and Consumer Services*, Vol. 15, pp. 443–451. doi:10.1016/j.jretconser.2007.11.002.

Elms, J., de Kervenoael, R. and Hallsworth, A. (2016), "Internet or store? An ethnographic study of consumers' internet and store-based grocery shopping practices", *Journal of Retailing and Consumer Services*, Vol. 32, pp. 234–243. doi:10.1016/j.jretconser.2016.07.002.

Eurostat (2016), "Modal split of passenger transport", available at: http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=tran_hv_psmod (accessed 15 March 2017).

Freathy, P. and Calderwood, E. (2013), "The impact of internet adoption upon the shopping behaviour of island residents", *Journal of Retailing and Consumer Services*, Vol. 20 No. 1, pp. 111–119. doi:10.1016/j.jretconser.2012.10.012.

Granzin, K.L. (1990), "The consumer logistics system: a focal point for study of the household-consumption process", *Journal of Consumer Studies and Home Economics*, Vol. 14 No. 3, pp. 239–256. doi:10.1111/j.1470-6431.1990.tb00052.x.

Granzin, K.L. and Bahn, K.D. (1989), "Consumer logistics: conceptualization, pertinent issues and a proposed program for research", *Journal of the Academy of Marketing Science*, Vol. 17 No. 1, pp. 91–101. doi:10.1007/BF02726358.

Granzin, K.L., Painter, J.J. and Bahn, K.D. (2005), "An empirical test of households ' participation in the distribution supply chain process", *Journal of Marketing Channels*, Vol. 12 No. 4, pp. 67–89. doi:10.1300/J049v12n04_05.

Granzin, K.L., Painter, J.J. and Valentin, E.K. (1997), "Consumer logistics as a basis for segmenting retail markets: an exploratory inquiry", *Journal of Retailing and Consumer Services*, Vol. 4 No. 2, pp. 99–107. doi:10.1016/S0969-6989(96)00034-3.

Guy, C. (2009), "Sustainable transport choices" in consumer shopping: a review of the UK evidence, *International Journal of Consumer Studies*, Vol. 33 No. 6, pp. 652–658. doi:10.1111/j.1470-6431.2009.00818.x.

Hagberg, J. and Normark, D. (2015), "From basket to shopping bag: retailers' role in the transformation of consumer mobility in Sweden, 1941-1970", *Journal of Historical Research in Marketing*, Vol. 7 No. 4, pp. 452–475. doi:10.1108/JHRM-06-2014-0016.

Hagberg, J., Sundström, M. and Egels-Zandén, N. (2016), "The digitalization of retailing: and exploratory framework", *International Journal of Retail & Distribution Management*, Vol. 44, No. 7, pp. 694-712.

Hiselius, L.W., Rosqvist, L.S. and Adell, E. (2015), "Travel behaviour of online shoppers in Sweden", *Transport and Telecommunication*, Vol. 16 No. 1, pp. 21–30. doi:10.1515/ttj-2015-0003.

Hjorthol, R.J. (2002), "The relation between daily travel and use of the home computer", *Transportation Research Part A: Policy and Practice*, Vol. 36 No. 5, pp. 437–452. doi:10.1016/S0965-8564(01)00012-X

Hjorthol, R.J. (2009), "Information Searching and Buying on the Internet: Travel-Related Activities?" *Environment and Planning B: Planning and Design*, Vol. 36 No. 2, pp. 229–244. doi:10.1068/b34012t.

Hsu, M.K., Huang, Y. and Swanson, S. (2010), "Grocery store image, travel distance, satisfaction and behavioral intentions", *International Journal of Retail & Distribution Management*, Vol. 38 No. 2, pp. 115–132. doi:10.1108/09590551011020129.

Hultman, J. and Elg, U. (2013), "Country Report Sweden", *European Retail Research*, Vol. 26, No. 2, pp. 151-166. doi:10.1007/978-3-658-00717-1_7.

Ibrahim, M.F. (2003), "Car ownership and attitudes towards transport modes for shopping purposes in Singapore", *Transportation*, Vol. 30 No. 4, pp. 435–457. doi:10.1023/A:1024701011162.

Jespersen, P.H. (2004), "The transport content of products", *World Transport Policy & Practice*, Vol. 10 No. 3, pp. 28-35.

Jiao, J., Moudon, A. and Drewnowski, A. (2011), "Grocery shopping: how individuals and built environments influence choice of travel mode", *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 2230 No. 1, pp. 85-95, doi: 10.3141/2230-10.

Jiao, J., Moudon, A. and Drewnowski, A. (2016), "Does urban form influence shopping frequency? A study from Seattle, Washington, USA", *International Journal of Retail & Distribution Management*, Vol. 44 No. 9, pp. 903-922, doi: 10.1108/IJRDM-06-2015-0091.

Kahn, B.E. and Schmittlein, D.C. (1989), "Shopping trip behavior: an empirical investigation", *Marketing Letters*, Vol. 1 No. 1, pp. 55–69. doi:10.1007/BF00436149.

Kantar (2016), *The future of e-commerce in FMCG*, available at: https://www.kantarworldpanel.com/global/Publications (accessed 15 March 2017).

Kent, J. (2013), *Secured by Automobility : Why Does the Private Car Continue to Dominate Transport Practices?* Doctoral Thesis, University of New South Wales.

Li, Z. and Hensher, D. (2013), "Crowding in public transport: a review of objective and subjective measures", *Journal of Public Transportation*, Vol. 16 No. 2, pp. 107–134. doi:10.5038/2375-0901.16.2.6.

Limanond, T., Niemeier, D.A. and Mokhtarian, P.L. (2005), "Specification of a tour-based neighborhood shopping model", *Transportation*, Vol. 32 No. 2, pp. 105–134. doi:10.1007/s11116-004-6992-1.

McKinnon, A.C., Browne, M., Piecyk, M. and Whiteing, A. (2015), *Green Logistics : Improving the Environmental Sustainability of Logistics*, Kogan Page, London, UK.

Nielsen (2015), "The Future of Grocery: E-commerce, digital technology and changing shopping preferences around the world", available at: http://www.nielsen.com/us/en/insights/reports/2015/the-future-of-grocery.html (accessed 15 March 2017).

Nijland, L., Arentze, T. and Timmermans, H. (2013), "Representing and estimating interactions between activities in a need-based model of activity generation", *Transportation*, Vol. 40 No. 2, pp. 413-430. doi:10.1007/s11116-012-9423-8.

Nilsson, E., Gärling, T., Marell, A. and Nordvall, A. (2015), "Who shops groceries where and how? The relationship between choice of store format and type of grocery shopping", *The International Review of Retail, Distribution and Consumer Research*, Vol. 25 No. 1, pp. 1–19. doi:10.1080/09593969.2014.940996.

OECD (2017), "Final consumption expenditure of households", available at: https://stats.oecd.org/Index.aspx?DataSetCode=SNA_TABLE5 (accessed 15 March 2017).

Pucher, J. and Buehler, R. (2008), "Making cycling irresistible: lessons from the Netherlands, Denmark and Germany", *Transport Reviews*, Vol. 28 No. 4, pp. 495–528. doi:10.1080/01441640701806612.

Recker, W. W. and Stevens, R. F. (1976), "Attitudinal models of modal choice: The multinominal case for selected nonwork trips", *Transportation*, Vol. 5, pp. 355–375.

Rotem-Mindali, O. and Weltevreden, J.W.J. (2013), “Transport effects of e-commerce: what can be learned after years of research?” *Transportation*, Vol. 40 No. 5, pp. 867-885. doi:10.1007/s11116-013-9457-6.

Samli, A.C., Pohlen, T.L. and Jacobs, L. (2005), “Developments in retail logistics”, *Journal of Marketing Channels*, Vol. 13 No. 2, pp. 81–98. doi:10.1300/J049v13n02_05.

Schmöcker, J. D., Quddus, M. A., Noland, R. B. and Bell, M. G. H. (2008), “Mode choice of older and disabled people: a case study of shopping trips in London”, *Journal of Transport Geography*, Vol. 16 No. 4, pp. 257–267. doi:10.1016/j.jtrangeo.2007.07.002.

SteadieSeifi, M., Dellaert, N.P., Nuijten, W., Van Woensel, T. and Raoufi, R. (2014), “Multimodal freight transportation planning: A literature review”, *European Journal of Operational Research*, Vol. 233 No. 1, pp. 1–15. doi:10.1016/j.ejor.2013.06.055.

Suel, E. (2016), “Modelling the Relationship between Multi-Channel Retail and Personal Mobility Behaviour”, available at: https://spiral.imperial.ac.uk/handle/10044/1/34922 (accessed 4 January 2017).

Svensk Digital Handel (2016), “Digital Mathandel Rapport 2016”, available at: https://dhandel.se/wp-content/uploads/2014/05/rapport-digital-mathandel-2016-web.pdf (accessed 15 March 2017).

Teller, C., Kotzab, H. and Grant, D.B. (2012), “The relevance of shopper logistics for consumers of store-based retail formats”, *Journal of Retailing and Consumer Services*, Vol. 19 No. 1, pp. 59–66. doi:10.1016/j.jretconser.2011.09.001.

Walters, R.G. and Jamil, M. (2003), “Exploring the relationships between shopping trip type, purchases of products on promotion, and shopping basket profit”, *Journal of Business Research*, Vol. 56 No. 1, pp. 17–29. doi:10.1016/S0148-2963(01)00201-6.

World Bank (2016a), “Population density (people per sq. km of land area)”, available at: http://data.worldbank.org/indicator/EN.POP.DNST (accessed 15 March 2017).

World Bank (2016b), “Urban population (% of total)”, available at: http://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS (accessed 15 March 2017)

Table I. Frequency of travel mode choice for grocery shopping

| Share, % | Never | Once or a few times a year | A few times per month | A few times per week | Several times per week | Total | n |
|---|---|---|---|---|---|---|---|
| Car | 10 | 7 | 11 | 36 | 36 | 100 | 1574 |
| On foot | 29 | 13 | 16 | 21 | 21 | 100 | 1516 |
| Bicycle | 53 | 18 | 11 | 12 | 8 | 100 | 1474 |
| Public transport | 73 | 11 | 7 | 6 | 3 | 100 | 1467 |
| Home delivery | 92 | 4 | 3 | 1 | 0.2 | 100 | 1472 |

Source: National SOM survey, 2014.

Question: How often, during the last 12 months, did you get to the store in the following ways when buying groceries?

Scale compressed from what was originally a 7-point scale. Here, alternatives 2-4 (i.e., “sometime in the last 12 months”, “sometime in the past six months” and “sometime in the last three months”) are combined into “once or a few times per year”.

Table II. Correlations between various travel modes for grocery shopping

| | Bicycle | Car | Public transport | On foot | Home delivery |
|---|---|---|---|---|---|
| Bicycle | | -0.20** | | 0.27** | |
| Car | -0.20** | | -0.29** | -0.44** | |
| Public transport | | -0.29** | | 0.34** | 0.06 * |
| On foot | 0.27** | -0.44** | 0.34** | | |
| Home delivery | | | 0.06 * | | |

Source: National SOM survey, 2014.

Question: How often, during the last 12 months, did you get to the store in the following ways when buying groceries?

Scale: Never, sometime in the last 12 months, sometime in the last six months, sometime in the last three months, sometime in the last month, sometime in the last week, several times per week.

Spearman rank correlation, Rho, $p<0.05$*, $p<0.01$**.

Table III. Correlation between travel modes in grocery shopping and consumer characteristics, mobility conditions, shopping behaviour, and environmental interests and concerns

| | *Car* | | *Bicycle* | | *Public trans.* | | *On foot* | | *Home delivery* | |
|---|---|---|---|---|---|---|---|---|---|---|
| Spearman rank correlation | r | n | r | n | r | n | r | n | r | n |
| Age | 0.10 ** | 1574 | -0.10 ** | 1474 | -0.15 ** | 1467 | -0.17 ** | 1516 | -0.16 ** | 1472 |
| Gender (a) | 0.06 * | 1574 | 0.04 ns | 1474 | -0.10 ** | 1467 | -0.10 ** | 1516 | -0.03 ns | 1472 |
| Education | -0.06 * | 1552 | -0.13 ** | 1459 | 0.03 ns | 1452 | 0.12 ** | 1500 | 0.09 ** | 1457 |
| Income (personal) | 0.16 ** | 1507 | 0.04 ns | 1411 | -0.11 ** | 1410 | -0.01 ns | 1455 | 0.13 ** | 1412 |
| Household income | 0.17 ** | 1439 | 0.05 * | 1355 | -0,12 ** | 1352 | -0.06 ** | 1393 | 0.15 ** | 1353 |
| Full time employment (b) | 0.11 ** | 1501 | 0.08 ** | 1414 | 0.09 ** | 1408 | 0.01 ns | 1455 | 0.11 ** | 1412 |
| Place of residence (rural-urban) | -0.26 ** | 1536 | 0.13 ** | 1440 | 0.35 ** | 1435 | 0.45 ** | 1484 | 0.13 ** | 1440 |
| Marital status (c) | 0.19 ** | 1544 | -0.09 ** | 1443 | -0.23 ** | 1439 | -0.24 ** | 1487 | -0.00 ** | 1444 |
| Type of household (d) | 0.21 ** | 1212 | -0.00 ns | 1152 | -0.15 ** | 1157 | -0,15 ** | 1185 | 0.09 ** | 1152 |
| Living with children (b) | 0.10 ** | 628 | 0.09 * | 610 | -0.02 ns | 603 | -0.03 ns | 613 | 0.12 ** | 611 |
| Access to car in the household (b) | 0.53 ** | 1543 | -0.08 ** | 1440 | -0.35 ** | 1434 | -0.35 ** | 1481 | -0.04 ns | 1442 |
| Freq. of car use | 0.60 ** | 1543 | -0.13 ** | 1448 | -0,36 ** | 1442 | -0,41 ** | 1488 | -0,07 ** | 1449 |
| Freq. of public transport use | -0.33 ** | 1534 | 0.16 ** | 1447 | 0.55 ** | 1441 | 0.42 ** | 1487 | 0.09 ** | 1447 |
| Freq. of cycling | -0.16 ** | 1540 | 0.76 ** | 1450 | -0.08 ** | 1444 | 0.08 ** | 1487 | 0.02 ns | 1451 |
| Freq. of being in nature | 0.08 ** | 1540 | 0.02 ns | 1450 | -0.10 ** | 1443 | -0.10 ** | 1491 | -0.04 ns | 1451 |
| Distance to most-frequented food store | 0.40 ** | 1555 | -0.28 ** | 1458 | -0.18 ** | 1451 | -0,60 ** | 1499 | -0.02 ns | 1457 |
| Frequency of food purchases | 0,26 ** | 1566 | 0.05 ns | 1467 | 0.03 ns | 1460 | 0.19 ** | 1508 | -0.01 ns | 1466 |
| Frequency of eco-labelled food purchases | -0.00 ns | 1556 | 0.11 ** | 1462 | 0.04 ns | 1457 | 0.16 ** | 1504 | 0.08 ** | 1461 |
| Frequency of buying/ordering goods/services via Internet (not only groceries) | 0.00 ns | 1419 | 0.07 ** | 1353 | 0.06 * | 1339 | 0.09 ** | 1379 | 0.21** | 1344 |
| Anxiety about environmental pollution | -0.06 * | 1559 | 0.09 ** | 1466 | 0.09 ** | 1461 | 0.11 ** | 1510 | 0.02 ns | 1467 |
| Anxiety about climate change | -0.06 * | 1555 | 0.05 * | 1461 | 0.09 ** | 1456 | 0.10 ** | 1502 | 0.01 ns | 1461 |
| Membership in environmental org. | -0.06 * | 1492 | 0.08 ** | 1417 | 0.03 ns | 1414 | -0.02 ns | 1453 | 0.01 ns | 1420 |

Source: National SOM survey, 2014.

Question: How often, during the last 12 months, did you get to the store in the following ways when buying groceries? 7-point scale from 1= never to 7= several times a week

* Significant correlation, $p<0.05$, **significant correlation, $p<0.01$, one-tailed for the socio-demographic variables (rows 1–10), two-tailed for the remainder.

(a) Nominal scale, 1=woman, 2=man

(b) Nominal scale, 0=no, 1=yes

(c) Nominal scale, 1=single, 2=cohabitant, 3=married/partnered, 4=widow(er)

(d) Nominal scale, 1=live alone, 2=share household regularly

Table IV. Stepwise linear-multiple-regression analysis of travel mode choice in grocery shopping.

| | **Car** | | **Bicycle** | | **Public transport** | | **On foot** | | **Home delivery** | |
|---|---|---|---|---|---|---|---|---|---|---|
| Model | Variables Entered | Adjusted R Sq. | Variables Entered | Adjusted R Sq. | Variables Entered | Adjusted R Sq. | Variables Entered | Adjusted R Sq. | Variables Entered | Adjusted R Sq. |
| 1 | Frequency of car use (+) | 0.29 | Frequency of cycling (+) | 0.55 | Frequency of public transportation use (+) | 0.21 | Distance to most-frequented store (-) | 0.35 | Frequency of Internet purchases (+) | 0.07 |
| 2 | Distance to most-frequented store (+) | 0.35 | Distance to most-frequented store (-) | 0.59 | Frequency of car use (-) | 0.24 | Frequency of public transportation use (+) | 0.39 | Household income (+) | 0.09 |
| 3 | Frequency of cycling (-) | 0.37 | Frequency of car use (-) | 0.60 | Household income (-) | 0.26 | Place of residence (rural-urban) (+) | 0.41 | Place of residence (rural-urban) (+) | 0.10 |
| 4 | Frequency of public transportation use (-) | 0.38 | Frequency of eco-labelled food purchases (+) | 0.60 | Place of residence (rural-urban) (+) | 0.26 | Marital status (-) | 0.43 | | |
| 5 | | | | | Distance to most-frequented store (-) | 0.27 | Frequency of car use (-) | 0.44 | | |
| 6 | | | | | Marital status (-) | 0.28 | Frequency of eco-labelled food purchases (+) | 0.44 | | |

Source: National SOM Survey, 2014.

Question: How often, during the last 12 months, did you get to the store in the following ways when buying groceries?

Scale: Never, Sometime during the last 12 months, Sometime during the last six months, Sometime during the quarter, Sometime during the month, Sometime during the week, Several times a week.

(+) The variable is positively correlated with the dependent variable. (-) The variable is negatively correlated with the dependent variable

Criteria: Minimum correlation with dependent variable 0.10. Probability-of-F-to-enter $\leqslant$ 0.050. Probability-of-F-to-remove $\geqslant$ 0.100.

Control for collinearity: Maximum condition index (Ratio of eigenvalues) = 20.