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E-commerce and prevalence of last mile practices

Kristin Ystmark Bjerkan^{a*}, Astrid Bjørgen^{a,b}, Odd André Hjelkrem^a

^a*SINTEF, PB 4760 Torgarden, 7465 Trondheim, Norway*

^b*Norwegian University of Science and Technology, 7491 Trondheim, Norway*

Abstract

This study uses survey data collected from 500 individuals in the capital region of Norway to unveil demographic properties, travel behavior and last mile practices among e-commerce users. The study shows several correlations between travel behavior and last mile practices: users who prefer home delivery tend to travel less and are distinguished by fewer shopping trips and less car use. Home delivery is typically used in segments characterized by heavier goods while pick-up-points are used for smaller shipments.

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1. Introduction

E-commerce is one representation of how digital transitions continue to shape behavior and practices in individuals, organizations, systems and societies. In the transport domain, online shopping is expected to produce novel approaches in urban freight distribution as well as modified travel behavior among city dwellers (Maat and Konings 2018; Wang et al. 2018). These changes challenge city planners to take continuously evolving transport patterns and habits into consideration when designing and/or modifying urban spaces. Integrated city planning which facilitates sustainable mobility requires sufficient knowledge about the transformative effects of e-commerce (Pettersson et al. 2018).

In Europe, the number of online shoppers has increased by 85% in the last decade (Consumer Conditions Scoreboard 2017:92), and e-commerce is expected to comprise 36% of world trade by 2030 (World Economic Forum). More than 75% of Norwegians shop online (Fjørtoft 2017) and e-commerce continues to grow at a greater rate than conventional shopping (Virke 2017). The purpose of this paper is to describe the use of e-commerce and its impact on the personal travel of consumers. As such, this paper seeks to answer the following research questions: i) what

* Corresponding author. Tel.: +47 90992086.

E-mail address: kristin.ystmark.bjerkan@sintef.no

characterizes e-commerce users?, ii) what is the personal travel behavior of e-commerce users?, and iii) what are prevalent last mile practices among e-commerce users?

2. Research on e-commerce and transport

Research on e-commerce and transport can be characterized as diverse and inconsistent, both in terms of theoretical approaches, definitions, data, methodologies and findings. It is difficult to identify an obvious, overall direction, and existing research does not allow a definitive conclusion on the relationship between e-commerce and transport. There is a general assumption that e-commerce is a growing aspect of an increasingly digital era and that e-commerce continues to increase and spread to new markets and industries. Allen et al (2018) anticipate growth as a result of increased e-commerce in older age groups, strong e-commerce habits among younger age groups, reduced number of physical stores, more trade domains entering into e-commerce (i.e. groceries) and increased use of smart phones.

There is a growing body of research on the impact of e-commerce on freight transport. This research addresses issues relating to the prominence of home delivery transport in urban areas (Visser & Lanzendorf 2004; Maat and Konings 2018), returns and failed delivery (Visser et al. 2014; Morganti et al., 2014; Hendrickson et al., 2006), time windows (Allen et al. 2018; Manerba et al. 2018), cooperation and consolidation (Taniguchi & Kakimoto 2004; Zissis et al. 2018) and the changing nature of urban supply and value chains (Goodchild & Ivanov, 2018; Goodchild et al., 2018; Wygonik & Goodchild 2018; Henriksson et al. 2018; Visser et al. 2014).

Still, the majority of research investigates the impact of e-commerce on personal transport and the literature addresses a range of influences and implications. Based on a life cycle evaluation of e-commerce and in-store shopping, Hishier (2018) concludes that there is no necessary environmental benefit of e-commerce, as the environmental impact of e-commerce depends on the travel mode choices and consumer behavior. There is no general understanding in existing research about how and to what degree e-commerce influences personal transport and consumers' travel habits. Whereas several publications indicate that e-commerce substitutes shopping travel to physical stores, other publications suggest a small or non-existent impact on travel behavior.

E-commerce can alter personal mobility through substitution, modification, generation or neutrality (Mokhtarian & Solomon 2002). A number of studies indicate that e-commerce has a potential for increasing the sustainability of personal travel in that it replaces trips to physical stores (e.g. Weltevreden & Rietbergen 2007; Tonn & Hemrick 2004; Rosqvist & Hiselius 2016; Suel & Polak 2017; Sim & Koi 2002), but this effect might be overestimated as studies typically do not take into account chained trips (Rotem Mindali & Weltewreden 2013). Other studies show no impact or a complementary impact on personal travel (Calderwood & Freathy 2014; Hiselius et al. 2015; Zhou & Wang 2014; Weltevreden 2007) and most studies find a neutral or complementary effect (Ding & Lu 2017). Substituting physical travel with e-commerce is challenging because shopping represents a valued leisure activity (Rotem-Mindali 2010).

Existing research addresses several factors that influence correlations between e-commerce and travel behavior. The impact of e-commerce on personal travel largely depends on characteristics of the consumer, the household and localities (Zhou & Wang 2014; Farag et al. 2006). Edwards et al (2010) argue that the climatic impact of shopping depends on the consumer being willing to make several purchases on the same trip and using less polluting travel modes. Similar arguments are brought forward by others (van Loon et al. 2015; Seebauer et al. 2016). Impacts are also determined by the distance to the physical shopping location (Rosqvist & Hiselius 2016) and are discussed with regard to rurality/urbanity (Cárdenas et al., 2017). The impact of e-commerce further depends on how the deliveries are made, and increased use of pick-up-points in rural and suburban areas might produce more trips with private car (Morganti et al 2014). Impacts could also result from the degree to which consumers adopt new technologies and practices (innovation hypothesis) or their lack of access to physical stores (efficiency hypothesis) (Maat & Koonings 2018).

3. Methods and data

This study is based on a sample from a telephone survey among consumers in the Norwegian Capital region (the counties of Oslo and Akershus) about home delivery of meal boxes and groceries. The capital region was targeted because the population in this region is expected to have a higher overall use of e-commerce, confirmed by a test in a national web panel conducted prior to the survey. The survey aimed to recruit respondents whose households had used a service for delivery of meal boxes or groceries at least once the last two months. The survey was conducted over

telephone by an survey agency in the period November 2018 to January 2019 and respondents were recruited with an aim of achieving a sample representative to the capital region population in terms of age and gender.

The sample upon which this research is based was derived from the gross sample of this survey but is limited to all respondents who have at one point purchased non-groceries online. Seventeen respondents had never purchased non-groceries online or did not provide an answer and were excluded from the sample. Thus, the sample is comprised of 484 consumers aged 18- 87 and is described in further detail in Table 1.

Table 1. Description of sample used in the analyses

	N	%		N	%
Age			Gender		
20-29	70	15	Male	248	51
30-39	173	36	Female	236	49
40-49	145	30	Household gross income		
50-59	67	14	Less than 200 kNOK	8	2
60-69	13	3	200 -399 kNOK	47	3
70+	16	3	400-599 kNOK	37	8
Main activity			600-799 kNOK	39	8
Employed	429	89	800-999 kNOK	49	10
Student	23	5	1 000 - 1 500 kNOK	155	32
Retired	17	4	More than 1 500 kNOK	93	19
Other	15	3	Unknown	89	18
Education			Area of residency		
High school	70	15	City	292	60
College/university, less than 4 years	168	35	Neighbouring communities	122	25
College/university, 4 years or more	242	50	Outer capital region	70	15
Other	4	1			

3.1. Characteristics of e-commerce users

User characteristics are explored through comparisons between, i) the sample of e-commerce users and comparable data on the general population in the capital region, and ii) frequent and non-frequent users of e-commerce. Frequent users are defined as users who shop online at least once a month ($n = 56$) whereas non-frequent users shop online more seldom ($n = 428$). These groups are described with reference to demographic and socio-economic properties, as well as household and residential characteristics. Population data are provided by Statistics Norway.

3.2. Impacts on personal travel and last mile practices

Impacts of e-commerce on personal travel behavior are explored through investigations of travel data provided in a travel diary included in the telephone survey. All respondents have reported all travels made the day before the interview, including purpose, trip length (in time), all modes of transportation and, when relevant, main mode of transportation. In order to explore the potential impact of e-commerce on travel behavior, the analyses provides descriptive comparisons of travel behavior for frequent and non-frequent users of e-commerce. These analyses also include comparisons of two last mile practices; home delivery and pick-up points and their correlation with travel behavior.

Table 2. Definitions of measures and subsamples

Measure/subsample	Definition	N
Frequent user of e-commerce	Shops online monthly or more	56
Non-frequent user of e-commerce	Shops online less than monthly	428
Sole users pick-up-points	Usually relies exclusively on pick-up-points when receiving goods shopped online	170
Sole users home delivery	Usually relies exclusively on home delivery when receiving goods shopped online	72

4. Results

4.1. Users of e-commerce delivery services

Table 3. Descriptive comparison of frequent and non-frequent users of e-commerce, and general population in the capital region. Population data provided by Statistics Norway (ssb.no) unless otherwise specified.

	Frequent users (n=56)	Non-frequent users (n=428)	General population in capital region
Gender			
Male	79 %	48 %	50 %
Female	21 %	52 %	50 %
Age			
18-29	14 %	15 %	17 %
30-39	34 %	36 %	16 %
40-49	30 %	30 %	15 %
50-59	18 %	13 %	12 %
60-69	2 %	3 %	9 %
70+	2 %	4 %	10 %
Main activity			
Employed	93 %	88 %	66 %
Student	2 %	5 %	10 %
Retired*	4 %	4 %	17 %
Other	2 %	3 %	
Education			
High school	14 %	14 %	33 %
College/university, less than 4 years	38 %	34 %	28 %
College/university, 4 years or more	46 %	51 %	16 %
Other	2 %	1 %	23 %
Residential area			
City	66 %	60 %	53%
Neighbouring communities	23 %	26 %	24%
Outer capital region	11 %	15 %	22%
Household gross income			
Less than 200 kNOK	2 %	2 %	8 %
200 -399 kNOK	4 %	3 %	29 %
400-599 kNOK	11 %	7 %	22 %
600-999 kNOK	11 %	19 %	26 %
More than 1 000 kNOK	54 %	51 %	15 %
Unknown	20 %	18 %	
Residential type			
Building apartment	29 %	36 %	6%
House apartment	16 %	8 %	N/A
Attached row house	11 %	11 %	21%
Semi-attached house	11 %	13 %	16%

Single family home	34 %	32 %	57%
Other	0 %	1 %	0%
<hr/>			
Holds driver's license [†]			
Yes	91 %	89 %	85 %
No	9 %	11 %	15 %
<hr/>			
Average number of cars in household	1,16	1,18	1,31%
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Average size of household	3,29	3,18	2,13
<hr/>			
Children under 18 in the household			
Yes	64 %	61 %	31%
No	36 %	39 %	69%

Table 3 describes frequent- and non-frequent e-commerce and corresponding data on the general population. Compared to the general population the sample is only representative with regard to gender. It consists predominantly of respondents aged 30–49 years, who are mainly employed, hold a college or university degree, and have a higher household income than the general population. The sample mainly resides in the city and its neighboring communities.

The rate of employment is relatively high both for frequent and non-frequent users compared to the general population. The users are highly educated, and a large share hold a college or university degree of more than 4 years. Looking closer at frequent users of e-commerce, we see that they are mainly men, and in the age group 30–59. They live in the city centre building apartment or single-family homes. This in line with the assumption that users of e-commerce are resourceful in terms of economic capital and standard of residence. Also, e-commerce has a larger demand in cities than their outskirts. Holders of driver's licenses are more prominent among e-commerce users than the general population. This in contrast to number of cars in the household, which is lower among e-commerce users. The average size of households among the users of e-commerce are over 3 persons per household compared to 2.13 in the general population. Both frequent and non-frequent users to a higher degree have children in the household.

4.2. Personal travel behavior

Table 4 gives an overview of travel behavior in frequent and non-frequent users of e-commerce. None of these results are statistically significant but show a tendency of frequent users to conduct slightly fewer trips in total, and more trips as pedestrians, by bike, bus and boat/ferry. Frequent users further conducted 0.05 fewer shopping trips on the registration day and there is no difference in number of shopping trips which include car use.

Table 4. Travel behavior of subsamples. Average number of trips on registration day.

	Frequent e-commerce users (N=56)	Non-frequent e-commerce users (N=428)	Sole users pick-up-points (N=170)	Sole users home delivery (N=72)
Total	2.98	3.15	3.26	2.54
Car	1.5	1.51	1.62*	1.24*
Pedestrian	0.73	0.67	0.61	0.71
Bicycle	0.14	0.11	0.13	0.06
Bus	0.43	0.37	0.51**	0.25**
Tram and metro	0.29	0.42	0.40	0.32
Train	0.11	0.16	0.16	0.18
Boat and ferry	0.07	0.02	0.02	0.0
Shopping	0.29	0.33	0.40**	0.21**
Shopping with car	0.44	0.45	0.24	0.15

**p<0.1, *p=0.14

[†] Data for general population from the National Travel Survey of 2013–2014.

4.3. Last mile practices

This section investigates differences regarding use of pick-up-points (PUP) and home delivery. Table 4 presents travel behavior among respondents who usually use only home delivery or usually only pick-up-points when shopping online. The table shows that sole users of home delivery conduct less travel on the registration day than sole users of pick-up-points (PUP). They also conduct less travel by car (1.3), half as many shopping trips and fewer shopping trips which include car use. These tendencies are supported by a matrix of correlations (see Figure 1) between last mile practices (home delivery, pick-up-points) and travel behavior.

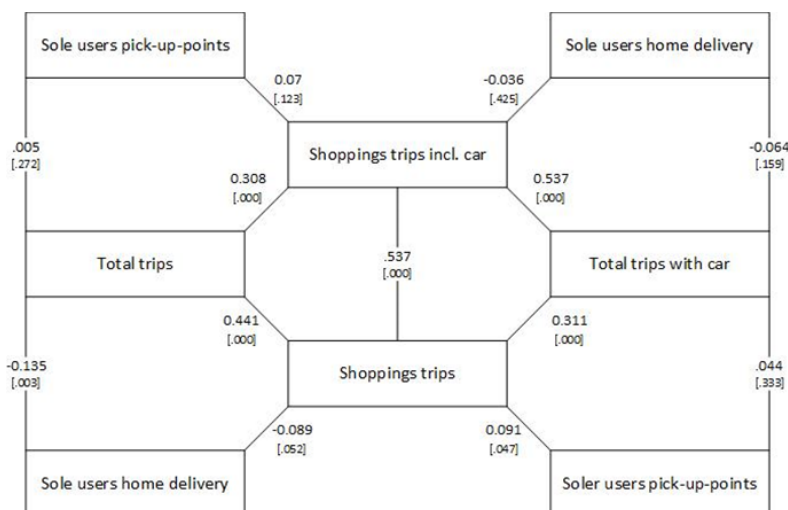


Fig. 1. Correlations between last mile practices and travel behavior (N=242).

The figure confirms that home delivery is associated fewer total trips and shopping trips, whereas use of pick-up-points is associated with more shopping trips. The results do not confirm, but rather indicate, that use of pick-up-points associates with more trips (total and with car), which could be an indication of different last mile practices for different types of purchases. Use of pick-up-points is particularly prominent in e-commerce segments such as electronics, toys, shoes and clothing (see Table 5). Nearly nine of the ten (88%) pick-up-point users shop for clothes and shoes online, compared to 72% of respondents who use home delivery ($p < 0.003$). Further, consumers who collect shoes and clothes at pick-up-points make more trips altogether and by car than those who pick-up other items (furniture, appliances). This probably relates to this groups engagement in e-commerce far more often than other groups, as well as the size and weight of packages.

Table 5. Prevalence of e-commerce segments and their association with last mile practices

E-commerce segment	Shops at least monthly (%)	Usually use PUP (%)	Usually use home delivery (%)	Usually other last mile practice (%)
Electronics	14	70	23	7
Appliances	2	34	53	13
Furniture	2	29	56	15
Shoes and clothing	32	78	15	7
Entertainment (books, music, film)	24	45	40	15
Toys	6	70	16	14
Other items	23	61	27	2

5. Conclusion

The results show that men and age groups 30-49 are overrepresented in frequent e-commerce usage. The rate of employment is relatively high among the users, and they are highly educated. Frequent users typically live in the

denser area of the region, in building apartments or single-family homes. The number of cars in the household among the e-commerce users are less compared to the general population even though users do hold a driver license. Over 60% of the users of e-commerce are in households with children, with more than 3 persons per household on average.

There is a lack of statistical significance in many results, but results show several tendencies pointing in the same direction. The results indicate that frequent e-commerce users overall travel less, but more often by bike and as pedestrians. Results are more conclusive when considering last mile practices and show that e-consumers which rely on home deliveries instead of pick-up-points travel less overall, less with car, conduct fewer shopping trips overall and have fewer shopping trips which include car use. As such, it does not appear to be e-commerce itself that impacts personal travel behavior, but rather last mile practices associated with e-commerce.

It is difficult to see any obvious and clear connection between the use of e-commerce generally and travel behavior. However, it is important to highlight that this study draws on the reported travel made the previous day by 500 respondents. A larger study, with data collection for a longer period of time, could provide more significant results. The next step should also include activity data from transport companies to study how e-commerce items are shipped in the last mile. The vehicle type, load factor and the spatiotemporal operation patterns will help to assess the sustainability of the last mile deliveries, in contrast to personal shopping trips and how they are characterized. Further, the sample in this study being drawn from a larger sample of e-grocery users implies that the results are not necessarily representative for e-commerce users overall, as particularities with users of e-groceries (e.g. Bjerkan et al 2019) might produce non-representative travel behavior and last mile practices.

From the introductory presentation of research on e-commerce and transport, it is clear that there is inconsistency in existing research regarding the relationship between shopping behavior and travel behavior. This might indicate that the variations in behavior are large, on both individual and sample level. Therefore, more studies on a bilateral level should be performed in order to assess the transferability of such results between countries.

Continued growth in e-commerce will set even higher demands for transport companies. Improved last mile solutions are important to tackle the increased amount of goods, especially related to the final fifty feet of home deliveries. The results indicate that lightweight and more frequent segments are delivered through PUP, while heavier and less frequent segments are delivered in the vicinity of the home. Impacts on freight transport will also depend on policy development. For instance, reduced car use might produce more use of e-commerce, which in turn could increase deliveries of large items in residential areas, e.g. appliances and furniture. Correspondingly, the strain on PUP will increase, unless measures are implemented to alleviate these developments. As alternative home delivery options emerge, we might expect a shift from PUP to home delivery, even for smaller goods, such as clothing and electronics. This calls for innovation in last mile practices, as well, e.g. smaller, slower, smarter and more sustainable vehicles, to avoid increased exposure of large trucks near people's homes.

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