Does buying intangible services online increase the frequency of trips to consume these services?

Abstract: Numerous studies have investigated the travel effects of online purchases. However, compared to tangible goods (e.g., books, electronics, and clothes), very limited attention has been paid to online purchases of intangible services (e.g., hairdressing, dining out, and visits to movie theatres, zoos, and local theme parks). Utilizing data obtained from 733 structured interviews in Beijing, China, this paper aims to examine the influence of buying intangible services online on trip frequency. The results indicate that – because of buying intangible services online – 52% of respondents indicated an increase in travel frequency to use these services, while only 7% indicated a decrease in the frequency. More importantly, those who indicate an increase in travel frequency are inclined to travel longer distances to use these services. Therefore, purchasing intangible services online may impose additional pressure on transportation systems. Applying a multinomial logistic regression method, we additionally reveal the influential factors of changes in travel frequency. The results show that – due to buying intangible services online – people with lower accessibility to shopping centers and bus stops are less likely to increase and even more likely to decrease the frequency of travel to use these services.

Keywords: online purchases; intangible services; travel frequency; built environment; Beijing (China)

1. Introduction

Nowadays, online purchases are widely adopted around the world. In 2019, the global online retail sales reached approximately US $ 3.5 trillion, accounting for 16.4% of the total retail sales (Young, 2019). Meanwhile, 1.45 billion people purchased online worldwide in 2018, which was 9% higher than that in 2017 (UNCTAD, 2020). The great use of online purchases may alter shopping travel behavior, thus profoundly influencing transportation systems. To date, using empirical evidence from various countries, numerous scholars have explored the relationship between online purchases and travel behavior. However, existing work shows mixed outcomes. In particular, there still exists a debate of whether online purchases result in more or fewer trips for consumers (Cao et al., 2012; Etminani-Ghasrodashti & Hamidi, 2020; Lee et al., 2017; Shi et al., 2019; Xi et al., 2020; Zhen et al., 2016; Zhou & Wang, 2014). Since previous studies fail to reach a consensus, it remains unknown whether purchasing online is a solution or a challenge for transportation systems.

Traditionally, products are categorized into two types: goods (normally with a nature of tangibility) and services (normally with a nature of intangibility) (Hill, 1999). For example, books, clothes, groceries, and electronics are typically treated as ***tangible goods***, and hairdressing, dining out, and visits to movie theatres, zoos, and local theme parks are often regarded as ***intangible services*** (Ding & Keh, 2017; Shi et al., 2020a,b; Sun et al., 2012)[1]. Some studies emphasize that the travel impacts of online purchases for consumers may differ between tangible goods and intangible services (Clark & Unwin, 1981; Shi et al., 2020a). Generally, tangible goods are transported to designated places after being paid for online. Consumers do not need to travel to stores to collect them. In contrast, intangible services are non-transportable (Nugraha, 2020; Shi et al., 2020b). After ordering or purchasing them online, people must make a trip to consume them. As a result, buying intangible services online will likely not replace trips (Clark & Unwin, 1981; Shi et al., 2020a).

It can even be assumed that buying intangible services online is apt to generate more trips for consumers, because purchase demand might be promoted by online buying in four aspects. First, e-retail websites provide easy and low-cost access to a wide variety of services that consumers would otherwise not have been aware of (Anderson et al., 2003; Shi et al., 2019). Second, the price of online products is usually lower. People can buy more services online using the same amount of money as before (Rotem-Mindali & Weltevreden, 2013). Third, consumers can easily acquire service information when purchasing online, which may help them save time. The saved time can then be used to purchase more. Fourth, before traveling to consume a service, people can make a reservation for the service by purchasing it online. Online buyers can benefit from buying intangible services online in the abovementioned four ways, possibly leading to an increase in purchase demand. This may generate more trips (i.e., complementary effect) to use these services, thus imposing extra pressure on transportation systems. Therefore, empirical evidence is urgently needed to verify whether buying intangible services online is a challenge for transportation systems. However,

[1]Apart from tangible goods and intangible services, there are some digital products such as online movies and music, digital games, electronic books, and software. Because these digital products are intangible but often treated as goods (Nugraha, 2020), they can be called ***intangible goods*** (Hill, 1999). Like tangible goods, purchasing intangible goods online almost does not require consumers to travel, implying that they may have similar effects on travel for consumers. Therefore, both tangible and intangible goods are usually considered together when online purchase effects on travel are examined (e.g., Lee et al., 2017; Weltevreden, 2007; Weltevreden & Rietbergen, 2007, 2009).

previous studies particularly focus on tangible goods when empirically examining the travel effects of online buying (e.g., Cao et al., 2010, 2012; Etminani-Ghasrodashti & Hamidi, 2020; Shi et al., 2019). There is very little empirical attention paid to intangible services.

In addition, it is vital to further identify the factors influencing changes in trip frequency due to buying intangible services online, which helps provide insights into the mechanism behind the impacts of online purchases on travel. In particular, the issue of how the built environment influences changes in trip frequency due to online purchases needs to be addressed. As assumed before, buying intangible services online may have a complementary effect on travel frequency, thus being a possible challenge for transportation systems. Exploring the association of the built environment with changes in trip frequency due to online buying can provide helpful knowledge for deliberating whether built environment interventions are valid to tackle this transportation challenge. However, current studies rarely address this issue.

In the present study, empirical evidence from a Chinese context (i.e., Beijing) will be presented to fill the abovementioned knowledge gaps. To date, China has become the country with the biggest e-retailing sale among all countries. In 2017, China accounted for 42.4% of the value of worldwide e-retail transaction, while this was only 24.1% in the U.S. (McKinsey and Company, 2017). Furthermore, Chinese e-retailing sales for intangible services rose by 56.8% in 2016 (compared with 2015) to ¥ 612.4 billion (≈US $ 91.3 billion) (IResearch, 2017). Therefore, China is a suitable region to investigate the travel effects of buying intangible services online. Using empirical evidence from Beijing, China, this paper attempts to answer the following questions: (1) Does buying intangible services online increase the frequency of trips to use these services?; And, if yes, (2) what are the determinants of the increase in trip frequency, and does the built environment matter? In the following section, related work is reviewed. Data used in the study are introduced in Section 3, followed by the results in Section 4. We end this study with the conclusions, implications, and future research recommendations in the final section.

2. Literature review

2.1 Travel effects of online purchases

With a dramatic increase in online sales in recent years, online purchases have had increasing potential impacts on transportation systems. Therefore, a clear consensus about online purchase impacts on travel is urgently needed. However, current studies show conflicting findings with respect to the issue. The heated debate is whether purchasing online has a substitution or complementarity effect on travel frequency. Some researchers indicate that online purchases lead consumers to conduct more shopping trips, indicating a complementary influence (e.g., Cao et al., 2010, 2012; Ding & Lu, 2017; Lee et al., 2017; Zhen et al., 2016; Zhou & Wang, 2014). In contrast, some scholars reveal that online buyers tend to indicate a decrease in trip frequency because of online purchases, thus supporting a substitution effect (e.g., Weltevreden, 2007; Weltevreden & Rietbergen, 2007, 2009). Even in very recent empirical studies, there still exist contrasting outcomes (e.g., Colaço & e Silva, 2021; Etminani-Ghasrodashti & Hamidi, 2020; Lachapelle & Jean-Germain, 2019; Shi et al., 2019; Xi et al., 2020). Apart from the substitution and complementary effects, the modification and neutrality impacts are investigated in a few studies. For instance, some scholars

support a neutral impact scenario because they found that online buying has little influence on trip frequency (Calderwood & Freathy, 2014; Sim & Koi, 2002). Additionally, some studies suggest that travel distances/durations and mode choices are altered by online buying, thus implying a modification effect (e.g., Farag et al., 2007; Shi et al., 2020a).

These mixed outcomes may result from measure approaches (Rotem-Mindali & Weltevreden, 2013). Two approaches are frequently used in previous studies: quasi-longitudinal analysis (i.e., capturing the self-reported changes in travel frequency before and after starting to purchase online) and cross-sectional analysis (i.e., establishing a quantitative relationship between online purchase frequency and in-store purchase frequency at a certain point in time) (Xi et al., 2020). In existing studies – despite a focus on the same type of products (i.e., tangible goods) – the outcomes seem largely dependent on the analytical approaches (see Table 1). When using the cross-sectional analysis, researchers often reveal a positive relationship between online purchase frequency and in-store purchase frequency (e.g., Colaço & e Silva, 2021; Etminani-Ghasrodashti & Hamidi, 2020; Lachapelle & Jean-Germain, 2019; Lee et al., 2017). They thus conclude that online buying has a complementary effect on trip frequency. When applying the quasi-longitudinal analysis, previous studies tend to indicate a decrease in in-store purchase frequency due to online purchases, thus implying a substitution effect (e.g., Shi et al., 2019; Weltevreden & Rietbergen, 2007, 2009; Xi et al., 2020).

In general, a quasi-longitudinal analysis is expected to be more effective to capture a causality than a cross-sectional analysis (Mokhtarian & Cao, 2008). In particular, Xi et al. (2020) empirically explored online purchase effects on travel frequency by using both quasi-longitudinal and cross-sectional analyses. Consistent with previous studies, their work confirmed the great dependence of outcomes on methods (see Table 1). They specifically highlighted that the quasi-longitudinal outcomes are more reliable than the cross-sectional outcomes. However, the quasi-longitudinal design is not widely adopted, especially not in more recent studies. Therefore, additional empirical studies applying a more reliable method (e.g., quasi-longitudinal analysis) can add value to clarify this issue.

Moreover, as assumed before, online purchase impacts on travel frequency may depend on types of products (Rotem-Mindali & Weltevreden, 2013). Some researchers particularly propose that purchasing tangible goods and intangible services online may differentially influence travel frequency (Clark & Unwin, 1981; Shi et al., 2020a). However, almost all existing empirical studies focus exclusively on tangible goods rather than intangible services (e.g., Cao et al., 2012; Etminani-Ghasrodashti & Hamidi, 2020; Lachapelle & Jean-Germain, 2019; Shi et al., 2019; Xi et al., 2020; Zhen et al., 2016; Zhou & Wang, 2014) (see Table 1). Only one exception by Colaço and e Silva (2021) considering both tangible goods (e.g., groceries and clothes) and intangible services (e.g., dinning out service) indicated that online purchases are positively associated with in-store purchase frequency (i.e., complementarity effect). However, they did not particularly focus on intangible services by distinguishing them from tangible goods. Additionally, a cross-sectional method was applied in their work, which may lead to less reliable outcomes.

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Table 1 Summary of previous studies by analysis methods and types of products

Analytical method	Research	Data source	Modeling approach	Type of products	Conclusion[2]
Cross-sectional analysis	Cao et al., 2010	591 internet users in the Twin Cities area, the United States in 2008-2009	Ordered Probit Models	Tangible goods, such as books clothes, electronics	Complementarity
	Cao et al., 2012	539 internet users in the Twin Cities area, the United States in 2008-2009	Structural Equation Model	Tangible goods, such as books clothes, electronics	Complementarity
	Colaço and e Silva, 2021	400 residents in Lisbon, Portugal in 2020	Structural Equation Model	Tangible goods (e.g. groceries and clothes) and intangible services (e.g. dinning out service)	Complementarity
	Ding and Lu, 2017	537 e-shoppers in Beijing, China in 2012	Structural Equation Model	*Unavailable*	Complementarity
	Etminani-Ghasrodashti and Hamidi, 2020	526 residents in Shiraz metropolitan area, Iran in 2018	Structural Equation Model	Tangible goods, such as clothing, electronic devices, and books	Complementarity
	Farag et al., 2005	826 internet users in the center of the Netherlands in 2003	Path analysis	Tangible goods such as clothing, electronic devices, and books	Complementarity
	Farag et al., 2006	807 households in Utrecht, the Netherlands in 2003	Ordinary Least Squares regression	Tangible goods such as groceries, books, and clothes	Complementarity
	Farag. et al., 2007	826 internet users in the center of the Netherlands in 2003	Structural Equation Model	Tangible goods such as clothing, electronic devices, and books	Complementarity
	Lachapelle and Jean-Germain, 2019	8239 residents in Canada in 2010	Multinomial Logit Model	Tangible goods, such as clothing and gas	Complementarity
	Lee et al., 2017	2043 residents in Davis, the United States in 2009-2010	Pairwise Copula Model	Tangible and intangible goods	Complementarity

[2] Conclusions only regarding online purchase effects on in-store purchase (travel) frequency are reported.

	Zhen et al., 2016	963 residents in Nanjing, China in 2015	Ordered Probit Model	Tangible goods, such as books, clothing, electronics	Complementarity
	Zhou and Wang, 2014	85663 individuals in the United States in 2009	Structural Equation Model	*Unavailable*	Complementarity
Quasi-longitudinal analysis	Calderwood and Freathy, 2014	307 residents in the Scottish isles	n.a.	Tangible goods – i.e., groceries	Neutrality
	Shi et al., 2019	710 e-shoppers in Chengdu, China in 2016	n.a.	Tangible goods, such as clothing, cosmetics, and electronics	Substitution
	Sim and Koi, 2002	175 residents in Singapore	n.a.	Tangible goods, such as clothes, gifts, and shoes	Weak substitution (i.e., Neutrality)
	Weltevreden, 2007	3200 internet users in the Netherlands in 2004	n.a.	Tangible and intangible goods	Substitution
	Weltevreden and Rietbergen, 2007	3200 internet users in the Netherlands in 2004	n.a.	Tangible and intangible goods	Substitution
	Weltevreden and Rietbergen, 2009	3000 e-shoppers in the Netherlands in 2006	n.a.	Tangible and intangible goods	Substitution
Quasi-longitudinal analysis & cross-sectional analysis	Xi et al., 2020	1207 residents in Nanjing, China in 2018	Ordered logit model	Delivered products, such as groceries and delivered food	Quasi-longitudinal analysis: Substitution Cross-sectional analysis: Complementarity

136 n.a. – Not applicable.

2.2 Determinants of changes in travel frequency due to online purchases

In existing studies, scholars systematically demonstrate the factors influencing online purchase behavior. Their findings suggest that individuals' sociodemographics, car ownership, attitudes, internet experiences, and spatial attributes (e.g., residential locations and the built environment surrounding them) are significantly related to whether and how often people purchase products online (e.g., Cao et al., 2012; Etminani-Ghasrodashti & Hamidi, 2020; Lachapelle & Jean-Germain, 2019; Lee et al., 2017; Zhen et al., 2016). However, less empirical attention has been paid to the determinants of changes in trip frequency due to online buying. Only a few exceptions analyzing this aspect are the following.

Using data collected in the Netherlands, Weltevreden and Rietbergen (2007, 2009) revealed that people who are young, have low accessibility to physical stores or low enjoyment of in-store purchases, search for product information online frequently, and purchase online frequently are more inclined to substitute online purchases for in-store purchase trips. Shi et al. (2019) found that – in Chengdu, China – online buyers owning private cars and purchasing online frequently are less likely to reduce in-store purchase trips due to online purchases. Using evidence from Nanjing, China, Xi et al. (2020) indicated that people having higher educational attainments, higher household incomes, smaller household sizes, more private cars, longer durations of using smartphones, more shopping responsibilities, more frequent online purchases, and positive shopping attitudes tend to reduce in-store purchase trips due to online purchases. It should be noted that, however, these studies mainly concentrate on tangible goods and almost ignore intangible services.

More importantly, the role of built environment elements needs to be specifically taken into account. Purchasing online might be either a challenge or a solution for traffic congestion if online purchases increase or decrease trips. Linking the built environment and the likelihood of changing travel frequency due to online purchases can clarify whether built environment interventions are valid to alleviate transportation pressure through online purchases. In existing studies, researchers frequently examined the association of the built environment with online purchases (e.g., Cao et al., 2013; Etminani-Ghasrodashti & Hamidi, 2020; Zhen et al., 2018). However, the relationship between the built environment and changes in trip frequency due to online buying is rarely investigated. An exception by Weltevreden and Rietbergen (2009) indicated that e-shoppers with lower accessibility to physical stores are more likely to reduce travel frequency. However, their work investigated the issue in the Dutch context, which may limit the generalizability of outcomes to some extent. In addition, they mainly considered tangible goods rather than intangible services.

In sum, we argue that limited research has empirically examined whether and how buying intangible services online influences the frequency of trips made to use these services. This fails to verify whether purchasing intangible services online puts extra pressure on transportation systems and fails to reveal the mechanism behind the travel effects of buying intangible services online. Apart from the knowledge gap, recent studies seem to have a critical limitation when measuring the effects of online purchases on travel. A quasi-longitudinal design is usually considered more effective than a cross-sectional design when addressing the issue of travel impacts of online purchases ((Mokhtarian & Cao, 2008; Xi et al., 2020). However, the cross-sectional design is more often applied to resolve this issue, particularly in recent studies (e.g., Colaço & e Silva, 2021; Etminani-Ghasrodashti &

Hamidi, 2020; Lachapelle & Jean-Germain, 2019; Lee et al., 2017). Given the research gap and the methodological limitation, the present study – applying a quasi-longitudinal analysis – aims to: (1) examine the influence of buying intangible services online on the frequency of trips made to consume these services, and (2) explore the determinants of changes in trip frequency due to buying intangible services online (in particular analyze the role of the built environment).

3. Data

3.1 Study area

In this paper, data are derived from structured interviews executed in October and November 2015 in Beijing, China (see Figure 1). In the past decades, Beijing has experienced rapid urbanization. The population of Beijing reached 21.6 million in 2015, and the total gross domestic product (GDP) was up to ¥ 2.30 trillion (≈US $ 0.36 trillion) (NBSC, 2016). Beijing also has experienced high-speed informatization. Approximately 5 million households were internet subscribers in 2015. In addition, a high level of retail demand exists in Beijing. The total retail sales were more than ¥ 1.03 trillion (≈US $ 0.16 trillion) in 2015 (National Bureau of Statistics of China, 2016), suggesting a huge potential demand for online buying.

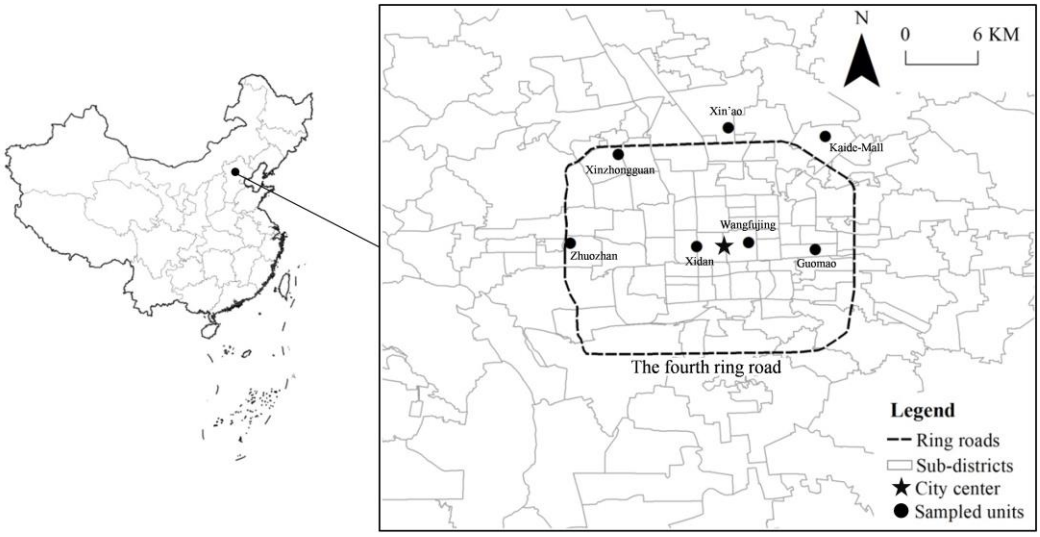

Figure 1 Study area and sampled units

3.2 Survey

The Urban and Regional Planning (URP) research group of Lanzhou University designed a structured questionnaire for the survey. In this questionnaire, intangible services that are frequently purchased online in China were listed as follows: hairdressing, photography services, dining out at restaurants, and visits to movie theatres, (karaoke) bars, zoos, local theme parks, fitness services, local tours and so forth.

Before starting interviews, researchers from the URP research group selected the sampled units applying a cluster sampling approach in four steps (Daniel, 2012). In the first step, those who had ever purchased intangible services online before were defined as the target population, because the

survey aimed to investigate online purchase behavior for intangible services among residents in Beijing. In the second step, 600-1000 respondents were determined as the sample size needed in the survey, so that ample data could be collected. In the third step, the sampled areas were determined as the main urban areas of Beijing (i.e., the areas which are mainly within the fifth ring road), where most people resided.

In the final step, the sampled units were selected. Ideally, participants should be recruited in residential communities. However, the residential communities were mostly gated in Beijing. It was not easy to recruit respondents there when researchers conducted a pretest. This is a common situation in urban China (e.g., Sun et al., 2017). Shopping centers – where online buyers (i.e., the target population) often visit to use intangible services ordered online – can be considered as the clusters of online buyers for intangible services, thus being the second ideal sampled units. According to the cluster sampling method (Daniel, 2012), researchers decided to perform interviews in city-level shopping centers that could largely serve residents across Beijing city. Notably, it is evident that spatial attributes play a role in online buying behavior (Maat & Konings, 2018; Zhen et al., 2018). City-level shopping centers are suitable places to approach residents with various spatial attributes, so that the spatial attributes can be taken into account. In the end, 7 shopping centers were geographically randomly determined as the sampled units (see Figure 1).

Adopting a convenience sampling approach, researchers from the URP research group performed face-to-face interviews in these sampled units. Data were recorded using paper-based questionnaires. In order to minimize sample selection bias, interviews were mainly performed during the entire day on weekends and after people finished work on weekdays. In the end, a total of 800 respondents participated in the survey, of which 733 valid records were used for the analysis in the present study.

3.3 Changes in travel frequency

In the survey, applying a quasi-longitudinal method (Xi et al., 2020), retrospective data were collected by asking respondents “After you started to purchase intangible services online, how did your frequency of trips made to use these services change?”. The answers to the question were set on a five-point scale from “decreased substantially” to “increased substantially”. The changes in travel frequency before and after online buying can thus be obtained from respondents’ answers.

Notably, only changes in travel frequency cannot fully depict changes in travel demand. In the situation where online buyers increase travel frequency but decrease one-way travel distance because of buying intangible services online, the total travel demand may barely be influenced by online purchases. In order to address this issue, we collected data in the survey to crudely assess whether and how the one-way travel distance was altered by online purchases. Normally, online buyers do not always purchase intangible services online. They sometimes use services without searching and ordering online beforehand. Participants were asked to indicate how far away their most visited place was to consume intangible services when purchasing them online and when not purchasing them online, respectively. Considering that the distance may differ by types of services, participants were asked to separately report distances for the following four categories of services: leisure service (e.g., visits to movie theaters and karaoke bars), local tour service (e.g., visits to local theme parks and zoos), dining out service (e.g., eating at restaurants and snack bars), and daily life service (e.g., haircutting service). In the end, 496, 244, 636, and 286 completely reported travel distances for

leisure service, local tour service, dining out service, and daily life service, respectively.

According to the self-reported distances, we can determine whether and how the one-way travel distance was changed by online purchases. When a respondent reported a longer distance when purchasing services online than that when not purchasing services online, it can be considered that online purchases make the respondent increase the travel distance to use these services. When a respondent reported a shorter distance when purchasing services online than that when not purchasing services online, it can be considered that online purchases make the respondent decrease the travel distance to use these services. Otherwise, a respondent does not change the distance when the respondent reported an insignificant difference in distances between when purchasing services online and when not purchasing services online.

3.4 Explanatory variables

In this dataset, we also collected data regarding respondents' sociodemographics, internet experiences, travel mode choices, online purchase attitudes and frequency, and the built environment, which will be used as explanatory factors to reveal the determinants of changes in trip frequency because of online buying.

Sociodemographics. Individuals' sociodemographics, including gender, age, education, and income are presented in Table 2. Of the total respondents, 61.3% are women and 51.2% are 25 years or younger (see Table 3). The China Electronic Commerce Research Center (2016) reported that 52.6% of online buyers in 2016 in China were women, and 51.2% were 26 years or younger (see Table 3). Notably, online buyers for both tangible goods and intangible services are included in the report. Just roughly speaking, therefore, women may be somewhat overrepresented in our dataset. In terms of age, our sample seems representative. Besides gender and age, it is unknown about the representativeness of samples with respect to other attributes.

Internet experiences and travel mode choices. Following previous studies (e.g., Shi et al., 2019), the number of years of using the internet on PCs is used to indicate individuals' internet experiences. Additionally, travel mode choices that were mostly adopted to use intangible services were collected for each respondent. The two variables are presented in Table 2.

273 Table 2 Basic characteristics of valid respondents

Variable	Description	N	%
Gender	Male	284	38.7
	Female	449	61.3
Age (Years)	20 or less (Value=1)	76	10.4
	21-25 (Value=2)	299	40.8
	26-30 (Value=3)	210	28.6
	more than 30 (Value=4)	148	20.2
Education	High school or less (Value=1)	52	7.1
	Colleges and technical school (Value=2)	132	18.0
	Undergraduate school (Value=3)	386	52.7
	Graduate school or more (Value=4)	163	22.2
Income (¥/month)	2000 or less (Value=1)	138	18.8
	2001-6000 (Value=2)	239	32.6
	6001-10000 (Value=3)	217	29.6
	More than 10000 (Value=4)	139	19.0
Years of internet use	5 or less (Value=1)	76	10.4
on PCs	6-9 (Value=2)	265	36.2
	More than 9 (Value=3)	392	53.5
Travel mode choice	Mostly driving or taxing	156	21.3
	Mostly public transport (PT)	332	45.3
	Mostly active modes (e.g., biking, walking)	245	33.4
Total		733	100.0

274 Table 3 Comparison of gender and age between valid respondents and the online buying population in China

	Valid respondents			Online buying population in China[3]	
	Description	N	%	Description	%
Gender	Male	284	38.7	Male	47.4
	Female	449	61.3	Female	52.6
Age (Years)	25 or younger	375	51.2	26 or younger	51.2
	More than 25	358	48.8	More than 26	48.8

275 *Online purchase attitudes and frequency*. The interviewers asked participants to respond to 18
276 statements concerning buying intangible services online. The answers range from strongly disagree
277 (value=1) to strongly agree (value=5). Given that some statements are potentially related to each
278 other, a factor analysis with principal axis factoring (Promax rotation) is performed, resulting in 5
279 factors (based on eigenvalue>1) (see Table 4). These factors explain 52.64% of the total extracted
280 variance. The scores on these factors are used to reflect online buying attitudes. In addition,
281 respondents were asked to report the frequency of buying intangible services online, which is
282 measured for a regular month (see Table 5).

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[3] Data were derived from the China Electronic Commerce Research Center (2016).

Table 4 Pattern matrix of factor analysis (N=732) (also see Shi et al., 2020a)

Factors	Statements	Loadings
Ease of travel	Buying online is a strategy to save travel time	0.93
	Buying online is a strategy to reduce travel distances	0.86
	The store/places that adopts the e-retailing strategy is situated within easy access	0.68
	I can find the sites of stores/places and plan travel routes online	0.42
Satisfaction	I usually purchase online again after making the first online purchase	0.79
	Compared to conventional purchases, I feel more satisfied with online purchases	0.68
	I am pleased to recommend online purchases to my friends and relatives	0.66
	I usually feel satisfied with online purchases	0.54
Following trends	Buying online is a popular lifestyle choice	0.94
	Buying online is a process of seeking novelty	0.79
	I choose to buy online because people around me do it	0.45
Convenience	It is convenient to select services online	0.86
	I can find a wide variety of services online	0.66
	I enjoy the freedom of the online buying environment	0.44
	I can find high-quality services online	0.44
	It is convenient to pay online	0.39
Price-consciousness	I enjoy the discounts when buying online	0.93
	Online services have lower prices	0.84

Table 5 Frequency of buying intangible services online

Online purchase frequency (times/month)	N	%	Mean (times/month)	Standard Deviation
4 or less	248	33.8		
5-10	282	38.5	8.8	8.2
11 or more	203	27.7		
Total	733	100.0		

Built environment. Previous studies often investigate the effects of individuals' home locations on online purchase behavior, because it is assumed that residential locations are expected to determine the accessibility to physical stores and thus has potential impacts on online buying (e.g., Farag et al., 2007). However, it is evident that in-store purchase travel is likely combined with other travel, particularly with commuting (Kalenoja & Rantala, 2007; Rotem-Mindali & Weltevreden, 2013). For example, someone lives in a suburban area with lower accessibility to physical stores and works in an urban area with higher accessibility to physical stores. The person probably visits stores on the way home from the workplace because of higher accessibility to physical stores. Apparently, the accessibility is mostly determined by departure locations rather than residential locations. Compared to residential locations, departure locations seem to be more associated with online buying behavior (Shi et al., 2019, 2020a,b). In the survey, participants were asked "where do you primarily depart from to travel to use intangible services?" to capture the departure locations.

Accordingly, the built environment surrounding departure locations are derived. In this study, four aspects are used to indicate the built environment around departure locations (see Table 6). Roughly speaking, the farther away from the city center (i.e., Tian'anmen Square, shown in Figure 1) in Beijing, the less urbanized the areas are. Therefore, the Euclidean distance from departure locations

to the city center is used to roughly indicate the urbanization level. Moreover, the number of bus stations, metro stations, and shopping centers within 800-meter buffer zone around departure locations are used to respectively measure accessibility to bus stations, metro stations, and shopping centers. Data regarding bus stations, metro stations, and shopping centers were collected from Map.Baidu.com[4] in November 2017.

Table 6 Built environment elements (N=728)

Variables	Definitions	Mean	S.D.
Distance to the city center	Euclidean distance from the primary departure location to the Tian'anmen Square (km)	11.3	7.3
Accessibility to bus stops	Number of bus stops within the 800 m buffer zone around the primary departure location	3.1	4.9
Accessibility to metro stops	Number of metro stops within the 800 m buffer zone around the primary departure location	1.0	0.8
Accessibility to shopping centers	Number of shopping centers within the 800 m buffer zone around the primary departure location	3.2	3.7

4. Results

4.1 Online purchase impacts on travel frequency

In this section, we aim to examine whether online buyers increase trip frequency to use intangible services after starting to buy them online. As Figure 2 shows, 384 (52%) respondents indicate a (substantial) increase in travel frequency since purchasing online, while only 50 (7%) indicate a (substantial) decrease. It suggests that – overall – online purchases of intangible services likely stimulate online buyers to conduct more trips to consume these services. As expected, this finding supports the complementary effect, which could be largely attributed to a possible generation effect of online buying on purchase demand.

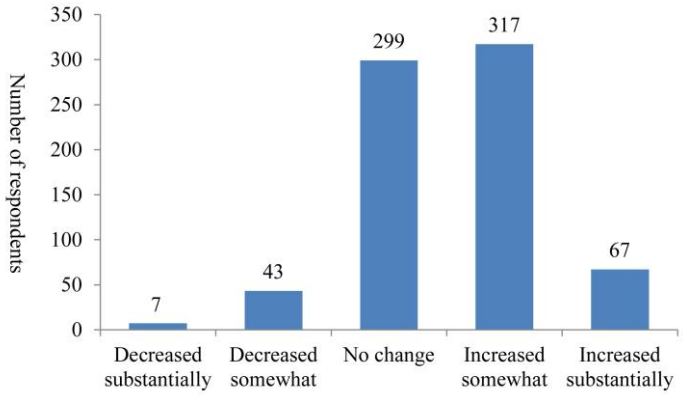

Figure 2 Changes in trip frequency

Furthermore, changes in one-way travel distance resulting from buying intangible services online are reported in Table 7. It indicates that considerable shares of respondents reported an increase in the one-way distance of travel to use four categories of services due to online purchases. Especially for dining out service and daily life service, the shares are up to 46.7% and 47.9%, respectively. In

[4] Map.Baidu.com is one of the most popular e-maps in China.

contrast, only limited percentages of respondents (11.1~15.7%) indicated to decrease the distance because of online buying. Therefore, purchasing intangible services online tends to facilitate online buyers to travel farther to consume them. This is possibly because online buyers can be aware of and order services in more distant places via the internet (Shi et al., 2020a,b).

Table 7 Changes in one-way travel distance

Category of services	N	Decrease in distance (%)	No change in distance (%)	Increase in distance (%)
Leisure service	496	11.1	52.2	36.7
Local tour service	244	11.1	50.8	38.1
Dining out service	636	12.9	40.4	46.7
Daily life service	286	15.7	36.4	47.9

Notably, many respondents indicated no significant changes in travel frequency because of purchasing online (see Figure 2). In the situation where the increase in one-way travel distance is mainly contributed by respondents who do not change and even decrease travel frequency, the increase in the total distance resulting from online purchases may be limited to a large extent. To clarify this issue, a cross-tabulation matrix between changes in travel frequency and changes in travel distance will be created. As shown in Figure 2, a limited number of respondents indicated a substantial decrease or a substantial increase in travel frequency. In order to improve the reliability of the analysis, respondents are categorized into three groups according to changes in travel frequency: decrease (combined substantial decrease and decrease, N=50), no change (N=299), and increase (combined substantial decrease and decrease, N=384). Changes in one-way travel distance are reported by the three groups in Table 8. It indicates that – for four types of services – people who reported an increase in travel frequency have a higher likelihood to increase the one-way travel distance to use services because of online buying.

Table 8 Changes in one-way travel distance by changes in travel frequency

Category of services	Group of respondents	N	Decrease in distance (%)	No change in distance (%)	Increase in distance (%)
Leisure service	Decrease in frequency	31	6.5	67.7	25.8
	No change in frequency	192	8.3	60.9	30.7
	Increase in frequency	273	13.6	44.3	42.1
Local tour service	Decrease in frequency	17	5.9	58.8	35.3
	No change in frequency	96	6.3	58.3	35.4
	Increase in frequency	131	15.3	44.3	40.5
Dining out service	Decrease in frequency	43	14.0	46.5	39.5
	No change in frequency	255	11.8	50.2	38.0
	Increase in frequency	338	13.6	32.2	54.1
Daily life service	Decrease in frequency	24	33.3	29.2	37.5
	No change in frequency	100	9.0	47.0	44.0
	Increase in frequency	162	17.3	30.9	51.9

There theoretically exist two situations when consumers purchase intangible services online. First, consumers have already decided where to consume a service and then order it online. Consequently,

online buying can hardly influence neither travel frequency nor travel distances. Second, consumers visit e-retail websites to search for intangible services because they have ever purchased them online before and been aware of the benefits of online purchases (e.g., larger search spaces, massive service information, and reduced prices). After searching online, they decide where to use a service and purchase it online before traveling to use it. In this situation, buying online can generate additional and longer-distance trips to use intangible services. According to the empirical outcomes in Figure 2 and Tables 7 and 8, the second situation seems more common than the first one in reality.

In sum, it is evident that – for online buyers – buying intangible services online tends to result in a longer total distance traveled to use these services, which may impose additional pressure on transportation systems. It should be noted that, however, only online buyers are considered in the present study. In theory, no effects on travel behavior can be expected for non-online buyers. Therefore, the pressure added by online buying to transportation systems is not as much as we observe for the general population.

4.2 Regression outcomes

In this section, we aim to reveal the factors influencing changes in trip frequency because of buying intangible services online. As mentioned above, sociodemographics, internet experiences, travel mode choices, online purchase attitudes and frequency, and the built environment are considered as the independent variables. The changes in trip frequency that are defined as three categories above (i.e., decrease, no change, and increase) are employed as the dependent variable. Subsequently, we develop an initial multinomial logistic (MNL) regression model including all factors. To increase the estimator efficiency, the backward stepwise approach is applied to remove far less significant independent factors (i.e., $p>0.30$) from the initial model. The generalized Hausman test suggests that the final model satisfies the assumption of independence of irrelevant alternatives.

The regression outcomes are shown in Table 9. Overall, sociodemographics, internet experiences, online purchase frequency and attitudes, and built environment factors have significant associations with changes in trip frequency. Educational levels are found to be positively associated with an increase in trips. People with better educational levels usually actively use the internet for other purposes (e.g., shopping), and thus tend to purchase online frequently (Anderson et al., 2003; Zhen et al., 2018), resulting in more likelihood of increasing trips. People who have lower incomes are more likely to increase shopping trips. The price of online products/services is usually relatively low (Etminani-Ghasrodashti & Hamidi, 2020). People with lower incomes are normally more sensitive to the price of services. Buying intangible services online is a possible strategy to save money for them. Therefore, the lower price of online services tends to encourage them to purchase online more frequently, possibly resulting in an increase in travel frequency.

People with a shorter history of using the internet on PCs are more likely to change (i.e., decrease or increase) trip frequency, which is somewhat surprising. There are two possible reasons. On the one hand, limited internet experience usually means that they cannot proficiently use the internet to purchase intangible services online. In some cases, buying online might even be a barrier for them. Therefore, online purchases tend to result in fewer trips made to use intangible services. On the other hand, some people with a short history of using the internet may be able to proficiently purchase online. Compared to those with more internet experience, they might more actively seek novelty and

have higher purchase intention via the internet. Consequently, purchasing online likely lead to an increase in travel frequency.

In addition, online purchase frequency and attitudes also play significant roles. It indicates that online purchases of intangible services more likely result in an increase in travel frequency for people who purchase online frequently. With respect to attitudes, people who are more cautious about the ease of travel are more likely to decrease travel frequency due to purchasing online. Moreover, respondents who find online purchases satisfying or convenient are significantly inclined to increase shopping trips. These findings are consistent with our expectations.

Lastly, the built environment is significantly associated with changes in trip frequency. Higher accessibility to bus stops is negatively correlated with a decrease in travel frequency, and higher accessibility to shopping centers is positively associated with an increase in travel frequency. This implies that – due to purchasing intangible services online – people with lower transport accessibility tend to decrease travel frequency, and those with higher accessibility to shopping centers are more likely to increase trip frequency. As indicated before, people need to travel to use intangible services after purchasing them online. Particularly, buying intangible services online makes online buyers travel farther. People with lower transport accessibility have more difficulty traveling farther to consume these services. Therefore, they have a higher likelihood to reduce travel frequency after starting to purchase online. In contrast, those with higher accessibility to shopping centers have more ease to travel to use these services. Thus, purchasing online tends to stimulate them to increase travel frequency.

Table 9 MNL for changes in shopping trip frequency (Ref.=No change)

Independent variables	Decrease		Increase	
	B	S.E.	B	S.E.
Gender (Male)	0.29	0.33	-0.18	0.18
Education	-0.06	0.20	0.26**	0.11
Income (¥/month)	0.12	0.19	-0.29***	0.09
Years of internet use on PCs	-0.77***	0.25	-0.23*	0.14
Travel mode choices				
Mostly using PT (Yes)	0.06	0.33	-0.26	0.18
Online purchase frequency	0.02	0.02	0.05***	0.01
Attitudes toward buying online				
Ease of travel	0.53**	0.21	0.00	0.10
Satisfaction	0.11	0.21	0.70***	0.12
Convenience	0.37	0.23	0.25**	0.12
Built environment				
Accessibility to bus stops	-0.08**	0.04	-0.01	0.02
Accessibility to shopping centers	0.06	0.04	0.04*	0.02
Constant	-0.44	0.74	0.52	0.44
Pseudo R^2	0.12			
N	727			
*p<0.1; **p<0.05; ***p<0.01				

5. Conclusions and discussion

In the past decade, numerous studies have illustrated the impacts of online purchases on travel. However, compared to tangible goods, online purchases of intangible services have received far less attention. In this study, data derived from 733 structured interviews in Beijing, China are used to address the issue. The analyses indicate that purchasing intangible services online tends to result in an increase in the frequency of travel to use these services. Meanwhile, people with an increase in travel frequency are more likely to travel farther to use the services ordered online. Therefore, buying intangible services online could be a challenge for transportation systems. Additionally, the MNL regression approach is applied to identify the factors influencing changes in trip frequency resulting from buying intangible services online. The outcomes suggest that sociodemographics, internet experiences, online buying frequency and attitudes, and the built environment are significantly associated with changes in travel frequency.

Our results extend the current knowledge in two aspects. First, previous studies usually ignore the travel impacts of buying intangible services online. The present study – applying a quasi-longitudinal analysis – suggests that buying intangible services online likely increases travel frequency. In contrast, using the same method (i.e., quasi-longitudinal analysis), previous studies mostly found a reduction in travel frequency due to buying tangible goods online (see Table 1). This finding empirically supports that online purchase effects on travel frequency do differ between tangible goods and intangible services. Second, we explored the factors influencing changes in trip frequency due to buying intangible services online, which provides valuable insights into the mechanism behind online purchase effects on travel.

From a practical perspective, retailers and urban managers may need to cope with the urban changes that result from buying intangible services online. On the one hand, scholars regularly postulate that physical retailers for tangible goods will lose revenue due to online purchases (e.g., Dolega & Lord, 2020; Shi et al., 2019; Weltevreden, 2007). Some direct evidence has even been found to support this hypothesis (e.g., Zhang et al., 2016). We assume that – different from retailers for tangible goods – retailers for intangible services may benefit from online buying and obtain added revenue since more visits to their places are generated. Thus, the number of these physical places might consequently increase in the long term.

On the other hand, buying intangible services online tends to be a challenge for transportation systems, since online buyers are inclined to increase trip frequency and the one-way distance to use the services. It should be noted that consumers purchase intangible services online not only in China but worldwide. For example, many restaurants outside China have their own online reservation systems where consumers can search and order dining services via the internet before visits to the restaurants. Therefore, the potential transportation pressure imposed by purchasing intangible services online seems a global problem. In particular, the COVID-19 pandemic has dramatically raised people's dependence on the internet use (Sun et al., 2020). It could also be expected that people will purchase more frequently online post-pandemic compared to before the pandemic. Therefore, the possible transport problem caused by buying intangible services online might get worse in the future.

Meanwhile, we reveal that – due to buying intangible services online – people with lower

accessibility to shopping centers and bus stops are less likely to increase and even more likely to reduce the frequency of travel to use these services. In addition, mainly focusing on tangible goods, the study by Weltevreden and Rietbergen (2009) also suggested a similar story that people with lower accessibility to physical shopping opportunities have a higher likelihood to reduce shopping trip frequency because of e-shopping. Apparently, both studies imply that reducing destination and transit accessibility can make online buyers travel less frequently. Therefore, transportation systems may not necessarily benefit from improving accessibility in the age of e-commerce. Notably, however, since lower destination and transit accessibility might not only result in lower travel frequencies, but also in lower public transport shares and higher levels of car use, it might not be a desired planning strategy.

In the present study, we particularly illustrate the influence of buying intangible services online on the frequency of trips made to use these services, leaving some issues unresolved. First, using the quasi-longitudinal method, we can only confirm that extra trips are generated by purchasing intangible services online. It is still unclear how many trips are exactly generated by online purchases. Second, tangible goods are not considered in the present study. The combined influence of buying both tangible goods and intangible services online on transportation systems is therefore unknown. Third, existing studies – including the present research – rarely investigate the net effects of online purchases on total trips (i.e., trips for all purposes). At least for intangible services, online buying results in more and longer-distance trips to consume these services, which possibly leads to a reduction in the frequency or distances of trips for other purposes. In this circumstance, the transportation pressure imposed by buying intangible services online could be somewhat offset. These issues may be worthy of investigation in future research and should be considered when making transportation policies.

Moreover, as indicated before, people tend to increase travel frequency due to purchasing intangible services online possibly because they can acquire massive information about the services online. In addition to the online buying behavior, general online searching activities (e.g., searching with e-maps) can also help people extend their search spaces and acquire high levels of service information. Therefore, these online searching activities are expected to have a similar effect (i.e., complementary effect) on trip frequency. Online searching activities (including but not limited to online buying behavior) may have a much larger complementary influence on trip frequency than we have observed in the present study. In future research, the issue may need to be empirically addressed.

There exist two limitations in the present study. First, the respondents were mainly recruited in city-level shopping centers of Beijing, China. This might result in a possible bias toward those who more likely visit these shopping centers to consume services purchased online. Those who usually travel to other places (e.g., community-level shopping centers) to use services may be underrepresented. Therefore, the generalizability of the findings might be limited – i.e., the travel effects of buying intangible services online are possibly exaggerated. Researchers may need to collect samples in more various types of spaces (e.g., parks, squares, and residential neighborhoods) and in other Chinese cities and other countries in future research. Second, the Pseudo R^2 (0.12) in the MNL model is relatively low. This means that some possible relevant factors (e.g., the history of smartphone use and time pressure) are not taken into account in the present study. This issue can be considered in future studies.

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