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The influence of the built environment on online purchases of intangible services: Examining the mediating role of online purchase attitudes

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Abstract

Via the internet, people can easily access high quantities of (information on) intangible services (e.g., dining out services, movie theater visits), often at low(er) prices. Therefore, purchasing these services online likely stimulates consumers to make extra trips for on-site consumption, thus posing a possible challenge for transportation systems. Meanwhile, attitudes toward online purchases may vary by the built environment. People in non-urban areas (compared to those in urban areas) may benefit more from online purchases due to lower accessibility to physical purchase opportunities. Therefore, they may have more positive attitudes toward online purchases and thus purchase more online. In this study, we analyze the effects of the built environment on online purchases – considering the potential mediating effects of attitudes – in order to clarify whether implementing built environment interventions is effective to cope with this transportation challenge. Using data acquired from 717 interviews in Beijing, China in 2015, a Structural Equation Modeling analysis indicates that higher employment density, lower accessibility to metro stations, and lower street density have direct and positive effects on online buying of intangible services. Additionally, higher accessibility to shopping centers has an indirect and negative influence on online buying behavior through attitudes toward online buying. Therefore, implementing built environment interventions might be valid to moderate travel demands resulting from online purchases of intangible services.

Keywords

Online shopping (e-shopping), built environment, online purchase attitudes, intangible services, Structural Equation Modeling, Beijing (China)

1 Introduction

With the widespread adoption of e-commerce over the past two decades, previous studies have frequently explored the influence of online purchases on travel behavior. It is widely acknowledged that travel effects of online purchases differ largely by types of products (e.g., Tonn and Hemrick, 2004; Weltevreden and Rotem-Mindali, 2009), and particularly between tangible goods (e.g., books, clothes, and electronics) and intangible services (e.g., dining out services, movie theatre visits, and hairdressing services) (Shi et al., 2021a). Notably, "telecommunications cannot replace movements which must involve the transport of people (such as hairdressing)" (Clark and Unwin, 1981, p.48). In other words, people must make trips to consume intangible services even after searching and paying for them via the internet (i.e., online purchase behavior[1]), because these services are non-transportable. Therefore, online buying can hardly be a substitute for such trips.

More importantly, Shi et al. (2021a) pointed out that buying intangible services online may increase purchase demand for four possible reasons. (1) People can easily acquire an unprecedented (and even excessive) amount of information on intangible services via the internet, which may lead to extra impulsive or unplanned purchasing behavior (Moe, 2003; To et al., 2007). (2) The price of online products is normally lower than that of in-store products (Gupta et al., 2004; Rotem-Mindali, 2010). Buying online can be a strategy for saving money. The saved money may be used for more purchases. (3) The efficiency of searching and paying for services is expected to increase via the internet, thus helping consumers save purchasing time. The saved time may be exploited for extra online purchases as well. (4) Consumers can make reservations for services and plan the routes of consuming trips through e-retail websites/Apps before departing for the trips. This helps consumers realize an effortless consuming experience, possibly stimulating purchase intentions (Wagner and Rudolph, 2010). The increased purchase demand will be translated into extra trips to use services, therefore generating additional transport pressure.

In principle, the built environment may be associated with online buying of intangible services. For example, people in non-urban areas (compared to their counterparts in urban areas) normally have fewer physical purchase opportunities surrounding them. When the internet is unavailable, they usually face more difficulties in acquiring service information or partaking trips to consume them. When purchasing services online, they can easily access massive service information and plan travel routes via the internet (Farag et al., 2006; Shi et al., 2020a), thus making the purchasing process and consuming trips effortless. Consequently, non-urban consumers are expected to have more gain from online buying compared to their counterparts in urban areas, hence making more frequent online purchases likely (Anderson et al., 2003). It is worthwhile to explore the associations between the built environment and online

[1] According to Mokhtarian (2004), Shi et al. (2020a) defined the activities of searching or paying for intangible services via the internet as online purchase behavior for intangible services. The definition is introduced to the present study.

purchases. By doing so, we can clarify whether land-use interventions are useful to manage online buying behavior, thus possibly mitigating travel demand. In the existing literature, most researchers empirically investigate the topic with a focus of tangible goods (e.g., Beckers et al., 2018; Loo and Wang, 2018; Maat and Konings, 2018; Ren and Kwan, 2009; Zhen et al., 2018). In contrast, little is known to date about how the built environment influences online buying of intangible services, although buying services online is more likely an emerging transport challenge.

Moreover, there is another research gap. As assumed above, the extent to which consumers benefit from online purchases may differ according to the built environment. Therefore, it can be assumed that online purchase attitudes of consumers vary as well by the built environment (Farag et al., 2005). The more consumers gain from online buying, the more positive attitudes they may have toward it. For example, a great variety of service information provided online may benefit more non-urban consumers, which may lead these consumers to have a more positive stance toward online buying (Wolfinbarger and Gilly, 2001; Monsuwé et al., 2004). According to the theory of reasoned action and planned behavior (Ajzen, 1991; Fishbein and Ajzen, 1975), people holding a positive stance toward a certain behavior (e.g., online buying) are more likely to perform that behavior (e.g., purchase online more frequently) (Hansen et al., 2004). Therefore, there likely exists an indirect association between the built environment and online purchase behavior through online purchase attitudes. It is regularly assumed that statistically significant association itself cannot robustly indicate causality. Another aspect – causal mechanism – can add value to strengthen a causal direction (Handy et al., 2005; Singleton and Straits, 2005). An investigation into the mediating effects of online purchase attitudes can provide a possible explanation for the causal direction from the built environment to online purchases and thus strengthen the causality. However, the indirect relationship is rarely considered in previous studies.

China has witnessed a considerable increase in the e-retailing market in recent years. As reported by McKinsey & Company (2016), the total transactions of e-retailing in China surpassed that in the U.S. after 2013 and became the largest one in the world. Chinese people buy intangible services online frequently. In 2016, online transactions for intangible services reached ¥ 612.4 billion (≈US $ 91.3 billion), accounting for approximately 7.5% of total retailing consumption (IResearch, 2017). In this context, using data collected in Beijing (China), we aim to answer: (1) (how) does the built environment directly influence online buying of intangible services? (2) (how) does the built environment indirectly influence online buying of intangible services through online buying attitudes? The remainder of this paper is organized as follows. Related studies are briefly reviewed in the next section, followed by the methodologies in Section 3. The analysis results are presented in Section 4. In Section 5, we end this study with conclusions and policy recommendations.

2 Literature review

2.1 Differences between tangible goods and intangible services

Online products are regularly classified into two categories: tangible goods (e.g., books, clothes, and electronics) and intangible services (e.g., dining out services and movie theater visits) (Francis and White, 2004; Keisidou et al., 2011; Shi et al., 2020a). In the field of marketing, together with buying tangible goods online, buying intangible services online is often treated as online purchasing behavior (Laroche et al., 2005; Lian and Lin, 2008). We first want to elaborate on two fundamental differences between online purchases of tangible goods and intangible services from a transportation point of view. On the one hand, they are expected to have different impacts on freight and personal transport demands.

- *Freight transport*. Tangible goods are normally delivered to online buyers after they are ordered online, which normally stimulates additional needs for freight transport (Weltevreden and Rotem-Mindali, 2009). In contrast, intangible services are non-transportable (Nugraha, 2020). Online buyers need to make a trip to consume a service after ordering it online. Therefore, different from tangible goods, purchasing intangible services online in theory has little influence on freight transport.

- *Personal transport*. For four possible reasons discussed in the Introduction, buying tangible goods and intangible services online can both result in additional purchase demand. It seems that personal trips are increased by online purchases of both tangible goods (e.g., Rotem-Mindali, 2010; Zhen et al., 2016; Zhou and Wang, 2014) and intangible services (e.g., Clark and Unwin, 1981; Shi et al., 2020a). Nonetheless, the increased shopping demand for tangible goods does not necessarily translate into more shopping trips, since the goods ordered online are normally transported by delivery systems (Lyons, 2002). Therefore, it is also likely that personal trips are partly replaced by e-shopping for tangible goods (e.g., Weltevreden and Rietbergen, 2007; Xi et al., 2020). In contrast, there exists less doubt about the effects of purchasing intangible services online on personal trips. Online buyers need to increase trips to use intangible services due to the increased purchase demand, since these services are non-transportable (Shi et al., 2021a).

In sum, it seems unclear whether buying tangible goods online is adverse for transportation systems, because it is hard to assess its net transport effects (combined personal travel effects and freight transport effects). In contrast, it is likely that buying intangible services (in contrast to tangible goods) online will increase personal trips, thus possibly being an emerging transport challenge.

On the other hand, it can be expected that accessibility to physical purchase opportunities (i.e., one of built environment elements) affects online purchases of tangible goods differently from intangible services. For tangible goods, people who have lower accessibility to physical purchase opportunities can benefit more from

high ease of gathering massive product information online and high convenience of home-delivery services. Therefore, it is regularly assumed that shopping accessibility is negatively associated with online purchases (e.g., Anderson et al., 2003; Farag et al., 2006). This assumption is subsequently confirmed by empirical studies (e.g., Loo and Wang, 2018; Ren and Kwan, 2009).

For intangible services, online buyers with fewer physical purchase opportunities can benefit more from the provision of massive service information online as well. Similarly, there may exist a negative association between physical purchase accessibility and online purchases. However, online buyers must make trips to consume services after ordering them online. Low accessibility to physical purchase opportunities means long travel distances and durations for online buyers. In this sense, low physical purchase accessibility does not necessarily lead to frequent online purchases. Apparently, the issue of how the built environment (particularly accessibility to physical purchase opportunities) influences online purchases of intangible services (compared to tangible goods) seems more complicated.

2.2 Built environment and online purchases

According to Ewing and Cervero (2010), the built environment is commonly measured by types of neighborhoods (e.g., urban neighborhoods *versus* suburban/rural neighborhoods) and more detailed elements (normally including density, destination accessibility, distance to transit, design, and diversity, i.e., the so-called five Ds). In this section, studies on the association between the built environment and online purchases will be briefly reviewed in relation to the two measurement methods.

In the early stages of the internet, scholars theoretically state that the spatial restrictions imposed by the built environment are largely overcome by using the internet (e.g., Cairncross, 1997). Thus, it is assumed that online activities (e.g., online buying) might differ less by the geographical context or the built environment (De Blasio, 2008; Farag et al., 2006). Subsequently, some researchers argue and confirm that the built environment does matter in online purchases. Anderson and colleagues (2003) assumed that there may be two possible hypotheses. The first one (named innovation diffusion hypothesis) postulates that – in urban neighborhoods – people have more tendency to purchase online, because they are relatively young, wealthy, better educated, and experienced in using the internet. The second one (called efficiency hypothesis) assumes that people in suburban/rural neighborhoods are more inclined to purchase online, because they normally have lower accessibility to physical purchase opportunities. Both hypotheses seem plausible. However, they did not provide empirical evidence to verify them.

Following the study by Anderson et al. (2003), quite a number of studies empirically explore the effects of types of neighborhoods and accessibility to physical purchase opportunities (i.e., destination accessibility) on online purchases. Some scholars reveal that urban contexts (compared to suburban/exurban contexts) have a positive association with online purchase frequency (Zhen et al., 2018; Zhou and Wang, 2014), supporting the innovation diffusion hypothesis. In contrast, several studies indicate that people in weakly urbanized areas (compared to strongly urbanized areas) and in

areas with fewer physical purchase opportunities tend to purchase more online (Krizek et al., 2005; Loo and Wang, 2018; Ren and Kwan, 2009), confirming the efficiency hypothesis. Interestingly, some other scholars find that residents in the both strongly urbanized and weakly urbanized neighborhoods are inclined to purchase online frequently (Farag et al., 2006; Hood et al., 2020; Kirby-Hawkins et al., 2019; Shi et al., 2019), supporting both hypotheses. Additionally, some studies indicate that both hypotheses seem invalid, because they fail to find significant correlations of urbanization levels and accessibility to physical purchase opportunities with online buying (Beckers et al., 2018; Ding and Lu, 2017; Lee et al., 2017).

Apart from types of neighborhoods and destination accessibility, other elements such as distance to transit and population density have also been considered in existing studies. For instance, Loo and Wang (2018) found that people with lower accessibility to metro stations tend to spend more time buying online at home. Ren and Kwan (2009) revealed that the white population density is positively related to individuals' likelihood of purchasing online. However, Lee et al. (2017) indicated insignificant associations between online purchase frequency and various built environment elements (e.g., population density, transit accessibility, and street connectivity). Apparently, scholars have not reached a consensus on how the built environment influences online purchases. It is therefore valuable to further empirically analyze this topic.

Moreover, many studies have widely confirmed that individuals' attitudes toward online buying considerably influence online buying behavior (e.g., Hansen et al., 2004; Hasan, 2010; Lee et al., 2017). Meanwhile, the extent to which people benefit from purchasing online may differ largely by the built environment. For instance, compared to people in strongly urbanized areas with high accessibility to physical purchase opportunities, those in weakly urbanized areas with low accessibility seem to benefit more from high convenience of online purchases (e.g., a great variety of products) (Shi et al., 2019). As a result, individuals' attitudes toward online purchases might considerably vary according to the built environment (Farag et al., 2005). In this context, it seems that the built environment can indirectly influence online purchasing behavior through online purchase attitudes. To our best knowledge, however, only Farag et al. (2005) explored the indirect influence of the built environment on online purchases through attitudes. In their work, types of neighborhoods (i.e., urban *versus* suburban neighborhood) were used as an exogenous variable representing the built environment, and attitudes toward online buying were used as an endogenous variable affected by the types of neighborhoods. However, they failed to find significant indirect effects on online purchases through attitudes.

There might be two possible reasons why several empirical studies fail to observe significant associations between the built environment, attitudes, and online purchases (e.g., Lee et al., 2017; Farag et al., 2005). First, most previous studies only explore the associations of built environment elements around residences with online buying behavior. However, online purchases may not be mainly influenced by residential locations. In reality, consuming trips are likely combined with commuting. In urban China, for example, there is a very common situation where people reside in the urban

fringe but work in the city center. In this case, they may like visiting restaurants for meals after work, because it is effortless for them to access dining services when departing from workplaces compared to from home. Because of fewer difficulties in directly consuming services, they have a lower likelihood to purchase online (i.e., search or pay for services online) beforehand even though living in the urban fringe. In this situation, online buying behavior is more influenced by workplaces rather than by residences. More generally speaking, online purchases may be more associated with locations where consumers mostly depart from to consume services. Notably, these locations may be individuals' homes, workplaces, or other places. Second, in some studies, only types of neighborhoods are used to indicate the built environment (e.g., Farag et al., 2005). Compared to detailed elements of the built environment, types of neighborhoods only provide limited information about the environment surrounding individuals' locations, possibly resulting in a weak link with online buying attitudes or behavior. In sum, future research needs to focus on more specific elements of the built environment surrounding a more appropriate place (e.g., workplace, primarily departure locations) instead of only residential places (Shi et al., 2019, 2020a, 2020b; Zhen et al., 2018).

As assumed before, compared to tangible goods, purchasing intangible services online is more expected to be an urgent challenge for transportation systems (Shi et al., 2020a, 2021a). An investigation into the effects of the built environment on online buying of intangible services will help verify whether built environment interventions are effective to cope with the challenge. Tangible goods are mostly considered in existing studies on the association between the built environment and online purchases (e.g., Ding and Lu, 2017; Shi et al., 2019, 2021b; Zhen et al., 2018), leaving intangible services underexposed. Therefore, the issue of how purchasing intangible services online is affected by the built environment needs to be addressed.

3 Methodologies

3.1 Data

Data regarding online purchases in this study are acquired from face-to-face interviews performed from 26 October to 28 November 2015 in Beijing, China. China had a total population of over 1.4 billion people in 2015, standing in the first place among all countries of the world. In the past three decades, China has experienced a dramatically rapid urbanization process. In 2020, 63.9% of the total population in China were urban inhabitants, while the share was only 26.4% in 1990. As the capital of China, Beijing – with a total population of 21.7 million people in 2015 – is one of the megacities in China. According to WorldPop (2020), the population density in 2016 is more than 10,000 persons/km^2 in most of the main urban areas of Beijing (i.e., within the fourth ring road) (see Figure 1). The spectacular growth of the urban population makes many Chinese cities (in particular megacities like Beijing) face severe transportation problems, including traffic congestion, air pollution, and so forth. In a 2015 report by Amap.com (2016) (one of popular e-maps in China), Beijing was rated as the most congested city in China. The average speed of vehicles during peak

hours was only 22.8km/h in that year.

Meanwhile, Beijing has experienced a rapid informatization process and has become one of the top e-retailing markets among Chinese cities (Shi et al., 2018; Zhen et al., 2015), suggesting considerable travel effects of online purchases. Specifically, people become more dependent on the internet because of the COVID-19 pandemic (Van Wee and Witlox, 2021). It can be expected that after the pandemic consumers will more often search or pay for intangible services online (before traveling to use them), compared to pre-pandemic. If – as assumed above – buying services online leads to extra travel demand, the congestion in Beijing will continue to get worse. Land-use policy (e.g., built environment interventions) is traditionally considered useful to cope with such transportation problems. Especially in Chinese cities like Beijing, the dramatic urban expansion results in unreasonable land use, which leaves considerable room for optimizing land-use structures. Therefore, it is worthwhile to explore the link between the built environment and online buying of intangible services in the context of Beijing. By doing so, we can yield land-use policy recommendations toward the development of sustainable transportation systems for such a city in the internet era.

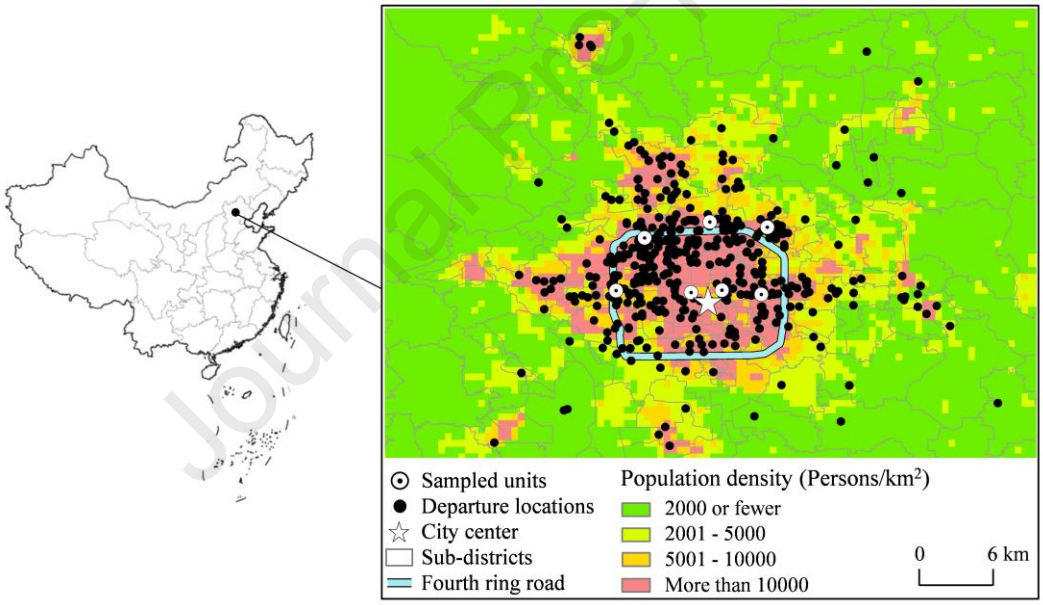


Figure 1 Study area

In the survey, the target population was defined as people who have ever purchased intangible services online before. Since intangible services are non-transportable, online buyers need to make trips to consume them after ordering them online. Thus, shopping centers (which usually contain intangible service providers such as movie theatres, restaurants) are places where online buyers often visit after ordering online. Each shopping center can be regarded as a cluster where online buyers for intangible services (i.e., the target population) can be easily approached. Using the cluster sampling method (Daniel, 2012), seven shopping centers in Beijing were selected as sampled units: Xinzhongguan shopping center, Xinao shopping center, Guomao shopping center, Xidan shopping center, KaideMall shopping center in Wangjing,

Wangfujing shopping center, and Zhuozhan shopping center (see Figure 1).

At these shopping centers, the interviews were conducted face-to-face during the full day on weekends and after work on weekdays. Participants were recruited following the convenience sampling method. Information provided by them was recorded by a paper-based questionnaire. In the end, approximately 2300 inhabitants were approached, and 800 accepted the interview, leading to a response rate of around 35%. Notably, Chinese consumers make frequent online purchases for dining out services, movie theatre visits, fitness services, and karaoke bars, implying a considerable effect on transportation systems. Therefore, this study particularly focuses on these services. Among the 800 respondents, 723 indicated that they had ever purchased these services online. Due to the lack of key information, 6 records are removed, resulting in 717 valid respondents. Table 1 shows the profile of these valid respondents.

Table 1 Profile of valid respondents (N=717)

Characteristics	Definitions	Frequency (N)	Percentage (%)
Gender	Male	272	37.9
	Female	445	62.1
Age (Years)	20 or younger (Value=1)	76	10.6
	21-25 (Value=2)	296	41.3
	26-30 (Value=3)	202	28.2
	Older than 30 (Value=4)	143	19.9
Education	High school or less (Value=1)	51	7.1
	Colleges and technical school (Value=2)	131	18.3
	Undergraduate school (Value=3)	374	52.2
	Graduate school or more (Value=4)	161	22.5
Income (¥/month)	2000 or less (Value=1)	138	19.2
	2001-6000 (Value=2)	233	32.5
	6001-10000 (Value=3)	213	29.7
	More than 10000 (Value=4)	133	18.5
Student status	Student	164	22.9
	Non-student	553	77.1
Years of using the	5 or less (Value=1)	75	10.5
internet on PCs	6-9 (Value=2)	257	35.8
	More than 9 (Value=3)	385	53.7
Total		717	100.0

Since the characteristics of the total online buying population for intangible services are unknown, it is not easy to judge the representativeness of the respondents used in the study. Nonetheless, there may exist some possible selection bias in the survey. In China, women visit shopping centers more frequently than men (Feng et al., 2015). As a result, respondents may be somewhat biased toward women. Furthermore, the cluster sampling technique has its disadvantage. In the case of the survey, all respondents were recruited at city-level shopping centers, possibly resulting in selection bias toward online buyers who actively visit these places. This means that consumers with higher purchase demand may be overrepresented to some extent.

Notably, in the present study, we mainly focus on the associations between the built environment, attitudes, and online purchases rather than on the prediction of travel behavior per se. It is regularly accepted that – in such an analysis – the possible selection bias is not particularly problematic, though it may result in biased estimation (Babbie et al., 2007; Handy et al., 2005; Lee et al., 2017). More details about the sampling administration can be found in Shi et al. (2020a).

Another data source – Map.Baidu.com – provides information on the built environment in this study. In recent years, an increasing number of empirical studies have derived Points of Interests (POIs) data from e-maps to measure the built environment (e.g., Zhao and Li, 2019; Zhu et al., 2019). Following them, we collected the POIs data of Beijing from Map.Baidu.com, which is one of the most used e-maps in China.

3.2 Measurement of online purchase effects on travel

Before analyzing the effects of the built environment on online purchases of intangible services, we will first clarify whether purchasing intangible services online makes consumers increase trips to use these services. In previous studies, a quasi-longitudinal design is highly recommended to measure the trip changes because of online purchases (Shi et al., 2021a; Xi et al., 2020). Applying the method, participants were asked to recall the history of purchasing intangible services online and answer the question "how did the number of trips to consume intangible services change for you after starting to purchase them online?". They could answer this question with "decrease", "no change", or "increase".

3.3 Modeling approach

In order to bridge links between the built environment, attitudes, and online purchases, a Structural Equation Modeling (SEM) is applicable to the study. Before modeling, the variables used in the SEM are described as follows.

Online purchases. In the survey, participants were asked to report their frequencies of consuming intangible services without online orders (i.e., conventional purchases) and consuming intangible services with online orders (i.e., online purchases) for a regular month, respectively. In this study, online purchases are measured in two ways (Maat and Konings, 2018; Shi et al., 2019). First, online purchase frequency is employed to reflect how often online buyers purchase intangible services online. Second, the share of online purchase frequency in total purchase frequency (i.e., the sum of conventional purchase frequency and online purchase frequency) is computed to reflect how likely respondents purchase online when they want to consume intangible services.

Online purchase attitudes. Following previous studies (Farag et al., 2005; Hasan, 2010; Lee et al., 2017; Shi et al., 2020a), 10 statements were used in the survey to measure the attitudes toward online purchases of intangible services. A factor analysis with Promax rotation and principal axis factoring was applied to reduce dimensions. Based on the principle of eigenvalue > 1, three factors were extracted: travel

convenience, purchase satisfaction & loyalty, and purchase convenience, explaining 51.5% of the total variance (Table 2).

Two points need to be clarified here. First, researchers usually measure online buying attitudes in multiple dimensions, such as perceived risk, price consciousness, travel convenience, purchase convenience, satisfaction, and loyalty (e.g., Al-Debei et al., 2015; Farag et al., 2005; Hasan, 2010; Lee et al., 2017; Li and Zhang, 2002; Shi et al., 2020a; Teo, 2002). However, the built environment is only associated with some of these dimensions in theory, mainly including travel convenience, purchase convenience, satisfaction, and loyalty. Therefore, the statements only regarding these relevant dimensions are used in the present study. Second, there is only one statement for satisfaction and two for loyalty. In such a situation, it is hard to distinguish the two dimensions in the factor analysis, although they are somewhat different in principle. The Cronbach's alpha of the three statements equals 0.75, suggesting reliable internal consistency between them. Therefore, it seems not materially problematic to integrate them. We recommend that in future research, satisfaction and loyalty are separately measured by improving the measurement scale.

Table 2 Pattern matrix of factor analysis (also see Shi et al., 2020a)

Factors	Statements	Loadings
Travel convenience	Purchasing online is a strategy for saving travel time	0.908
	Purchasing online is a strategy for reducing travel distances	0.851
	The service providers using the e-retailing strategy is situated within easy access	0.687
	I can locate service providers and plan the travel route online	0.416
Purchase satisfaction & loyalty	I usually purchase online again after the first experience of purchasing online	0.839
	I am contented to recommend online purchases to my relatives and friends	0.674
	I feel more satisfied with online purchases than traditional purchases	0.594
Purchase convenience	It is convenient to make the selection of services online	0.824
	I can discover a large variety of services online	0.623
	It is convenient to make payment for services online	0.464

Built environment. As argued before, online buying behavior might not be strongly associated with the built environment surrounding residential locations. Therefore, we aim to bridge the link between online purchases and the built environment around locations where respondents primarily depart from. The departure location of each respondent was captured by asking “Where do your trips to consume intangible services primarily depart from?” in the survey. These departure locations are displayed in Figure 1. It should be noted that a few trips may not depart from these locations. Therefore, some possible measurement errors may still exist.

As mentioned above, the built environment is usually measured by types of neighborhoods and the five Ds in transportation research (Ewing and Cervero, 2010). Notably, these elements are normally used as explanatory factors for general travel behavior. Not all of them in theory have explanatory power for online purchases. This may be the reason why little previous research strictly follows the principle of five Ds to selects built environment elements for explaining e-shopping. In the present study,

the built environment elements are selected for the following reasons.

According to the innovation diffusion hypothesis and efficiency hypothesis (Anderson et al., 2003; Farag et al., 2006), types of neighborhoods (e.g., urban, suburban, and exurban neighborhoods) and accessibility to opportunities for physical purchases are related to online purchases. In addition, given that public transit (e.g., bus and metro) is primarily used to travel to consume intangible services in Beijing (Shi et al., 2020a), the accessibility to public transit stations can be considered as an influential factor for purchasing intangible services online. Moreover, street density, residential density, and employment density are also taken into account for the following reasons. First, street density may indirectly reflect the accessibility to public transit services. Normally, high street density represents high density of transport activities, meaning that travel activities tend to be frequently performed. Therefore, public transit services per station is usually offered more frequently to meet higher travel demand in such areas. Second, high street density and high residential density are usually considered positively associated with high levels of walkability (Yang et al., 2021), which may influence consumers' decision of whether to use an online buying strategy. Third, areas with high residential density and high employment density tend to be commercially well-developed in Chinese cities. There likely exist more providers of intangible services. Fourth, according to the efficiency hypothesis, reducing time cost is one of the dominant motivations for purchasing online (Farag et al., 2006). High employment density is an indicator of high shares of business activities. Therefore, people in areas with high employment density tend to have high time pressure (particularly on workdays), thus possibly purchasing more online.

Accordingly, a total of seven elements of the built environment are finally selected. They are defined as follows:

- Distance to the city center – the straight-line distance between departure locations and the city center of Beijing (i.e., the Tiananmen Square);
- Accessibility to shopping centers – the number of shopping centers (indicated by POIs) within 800 m radius of departure locations;
- Accessibility to bus stations – the number of bus stations (indicated by POIs) within 800 m radius of departure locations;
- Accessibility to metro stations – the number of metro stations (indicated by POIs) within 800 m radius of departure locations;
- Street density – the length of street within 800 m radius of departure locations;
- Residential density – the number of residential locations (indicated by POIs) within 800 m radius of departure locations;
- Employment density – the number of office buildings (indicated by POIs) within 800 m radius of departure locations.

Notably, in Beijing, the level of urbanization continuously decreases from the city center to the fringe. The areas near the city center tend to be urban neighborhoods, and the areas far away from the city center are likely to be suburban or exurban neighborhoods. Thus, the straight-line distance between departure locations and the city center (i.e., the Tiananmen Square) is selected to roughly reflect types of neighborhoods. Additionally, as shopping centers often densely contain places

providing intangible services, the number of shopping centers (indicated by POIs) within 800 m radius of departure locations is used to directly reflect the accessibility to physical purchase opportunities.

Moreover, it is found that for access trips, the maximum walking distance is 800 m in China's large cities (Pan et al., 2010). Meanwhile, public transit is the dominant mode for traveling to consume intangible services in Beijing (Shi et al., 2020a). Therefore, a buffer size of 800 m is applied for the measurement of the built environment. In addition, all POIs data mentioned above were collected in November 2017, and the road network data were collected in July 2019.

Control variables. In addition, some factors such as sociodemographic factors and internet experience are found to be associated with online purchases and online purchase attitudes as well (e.g., Hasan, 2010; Zhen et al., 2018). Therefore, gender, age, educational level, income, student status, and internet experience were obtained as control variables. Apart from gender and student status, other factors are measured by ordinal scales (see Table 1).

Structural Equation Modeling (SEM). In the model, individuals' sociodemographics are employed as exogenous variables. Internet experience is used as an endogenous variable affected by sociodemographics (Ding and Lu, 2017). Online purchases are expected to be influenced by the built environment and attitudes, and attitudes are expected to be affected by the built environment. Online purchases, attitudes, and the built environment are assumed to be influenced by sociodemographics and internet experience (see Figure 2).

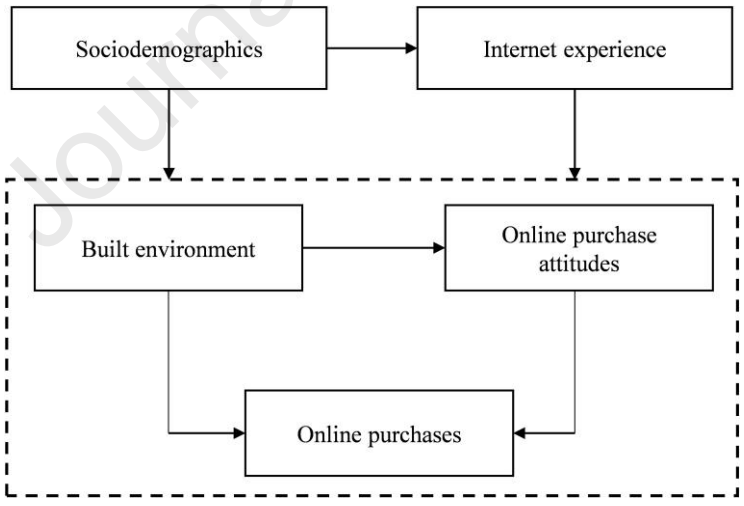


Figure 2 Conceptual framework

Given the size of valid samples (N=717), the Maximum Likelihood (ML) method is used for estimations. The initial model starts with all variables mentioned before. All exogenous variables (i.e., sociodemographic factors) are expected to be correlated with each other. In order to produce outcomes with high validity, the initial model is improved in two ways. On the one hand, the modification indices (M.I.) suggest that some built environment elements are highly correlated with one another, which is logic. Therefore, the interactions are added when the absolute M.I. are higher than 1.0.

On the other hand, the least significant link is removed by the backward stepwise principle until all links are at the significance level of 0.10 (Van Acker et al., 2019). A variable will be removed once it has no direct and indirect influence on online purchases. In the end, three variables indicating the built environment (distance to the city center, accessibility to bus stations, and residential density) and one variable indicating attitudes (purchase convenience) are removed from the initial model. Notably, the ML method requires data to satisfy the assumption of multivariate normal distribution. The normality test indicates that the final model violates the assumption, since the critical ratio is 17.69, which is higher than 1.96. In order to handle this issue, a bootstrap method with 1000 replicates is applied, and bias-corrected confidence intervals are used to indicate significance levels (Kline, 2015; Van Acker et al., 2019).

4 Results

4.1 Changes in travel caused by online purchases

In this section, we illustrate whether and how online buying of intangible services impacts trips for consuming services. The results indicate that 379 respondents (52.9%) reported an increase in consuming trips after online buying, while only 46 respondents (6.4%) reported a decrease. This means that – as expected – online buying of intangible services tends to result in extra trips to consume them. More detailed results can be found in Shi et al. (2021a).

We further examine whether the likelihood of increasing the number of trips differs by online purchase frequency. Respondents were first categorized into two groups according to the medians of online purchase frequencies (6 times/month) and shares (0.5), respectively. For online purchase frequency, a respondent was included in the group of “High” when the respondent purchased intangible services online more than 6 times/month, and otherwise the respondent was included in the group of “Low”. The same principle was applied to the online purchase share. Subsequently, changes in consuming trips due to online purchases were counted by groups in Table 3. It shows that only 43.0% of respondents with low online purchase frequency reported an increase in consuming trips, while it rises to 64.4% for respondents with high online purchase frequency. A chi-square test shows a significant difference between them (Chi.=32.58, Sig.=0.000). Meanwhile, 43.1% of respondents with low online purchase shares indicated an increase in consuming trips. The share is up to 67.4% for those with a high online purchase share. A chi-square test indicates a significant difference as well (Chi.=42.48, Sig.=0.000). The results suggest that the more people purchase intangible services online, the more likely they increase trips to consume services.

Additionally, purchasing intangible services also leads to considerable changes in one-way travel distances and travel mode choices. In theory, consumers’ search spaces for destination information are considerably extended when they purchase online. As a result, consumers tend to travel farther to consume services ordered online, thus increasing the use of motorized modes (Shi et al., 2020a, 2020b). In particular, Shi et

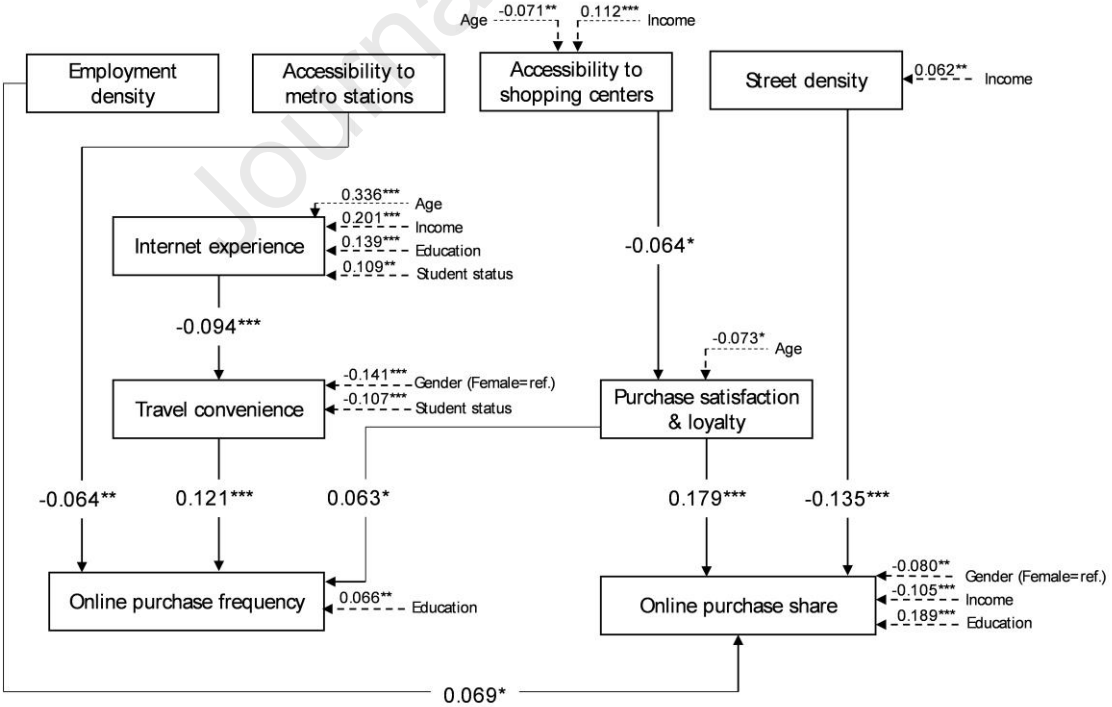
al. (2020a) revealed that – because of online purchases of intangible services – more than 25% of consumers tend to change from active travel modes (i.e., walking, cycling) to non-active travel modes. In sum, online buying of intangible services is adding pressure to transportation systems.

Table 3 Changes in the number of trips by groups

Group of respondents		Decrease		No Change		Increase		Total		Chi-square test
		N	%	N	%	N	%	N	%	
Frequency	Low	30	7.8	190	49.2	166	43.0	386	100.0	Chi.=32.58
	High	16	4.8	102	30.8	213	64.4	331	100.0	Sig.=0.000
Share	Low	29	6.8	215	50.1	185	43.1	429	100.0	Chi.=42.48
	High	17	5.9	77	26.7	194	67.4	288	100.0	Sig.=0.000
Total		46	6.4	292	40.7	379	52.9	717	100.0	

4.2 Influence of the built environment on online purchases

In this section, we mainly analyze the influence of the built environment on online purchases based on SEM outcomes. Figure 3 presents the estimate results of the final model. Fit indices of the final model fall in the range of recommended values (De Vos, 2019), indicating that the model fits the data well. Table 4 summarizes factors influencing online purchases and attitudes. Overall, the built environment, sociodemographics, and internet experience are directly or indirectly associated with online purchases and attitudes at the significance levels of 10%, 5%, or 1%.



Note: "*" p<0.10; "**" p<0.05; "***" p<0.01.

Goodness-of-fit: χ^2/df=3.878; RMSEA=0.063; CFI=0.921; GFI=0.961.

Figure 3 Model estimation results (standardized coefficients)

Built environment. Both direct and indirect associations of the built environment with online purchases are found. Accessibility to shopping centers is indirectly related to online purchases through attitudes. As shown in Figure 3 and Table 4, purchase satisfaction & loyalty is positively correlated with the frequency and the share of online purchases, suggesting that – as expected – people having positive attitudes toward online purchases tend to purchase more online. Meanwhile, accessibility to shopping centers is directly and negatively related to online purchase satisfaction & loyalty. This implies that online buyers with low accessibility to physical purchase opportunities have more satisfaction with and more loyalty to online purchases, possibly because they can benefit more from high ease of acquiring massive information about services online. Consequently, accessibility to shopping centers has indirect and negative effects on both online purchase frequency and share through purchase satisfaction & loyalty. This means that people with higher spatial proximity to physical purchase opportunities are less inclined to purchase online, which is in line with previous findings (Loo and Wang, 2018; Ren and Kwan, 2009).

Accessibility to metro stations is directly and negatively associated with online purchase frequency, which is a reasonable finding. People with higher accessibility to metro stations usually have more opportunities for trips. They are expected to travel frequently and farther in the daily life and thus have been aware of more information about intangible services. Therefore, they are less inclined to purchase online frequently, since they have a lower likelihood to acquire the information via the internet.

Similarly, street density is directly and negatively correlated with the share of online purchases. As assumed before, higher street density usually indicates more frequent public transit services and high levels of walkability, suggesting high ease of making trips as well. Therefore, it is also reasonable that they are less likely to buy intangible services online.

Employment density is directly and positively related to the share of online purchases. This may confirm that purchasing online can be a strategy for saving time. People who primarily depart for trips from areas with higher employment density may work there and mostly purchase intangible services on workdays. Therefore, they might have more time pressure and tend to purchase more online. Particularly for dining out services during lunch breaks, they are inevitably involved in fierce competitions with others. Making a reservation for dining services by online searching and payment beforehand is an ideal time-saving strategy for them. However, it seems somewhat surprising that the link between employment density and the attitude of travel convenience is insignificant. A possible explanation is that this attitude factor contains not only the time-saving attribute of online buying but also the ease of access to providers of online services, which may attenuate the link.

Sociodemographic factors and internet experience. The analysis outcomes show that sociodemographic factors are also significantly associated with both attitudes and online purchases. Regarding gender, both direct effects and indirect effects on online purchases are found. As shown in Figure 3 and Table 4, women are inclined to have

higher shares of online purchases. Furthermore, they also tend to have a positive attitude toward the convenience of travel with online orders. As expected, a positive direct link between the attitude of travel convenience and online purchase frequency is observed. Consequently, women have a higher likelihood to purchase online frequently. This finding is in line with previous results (e.g., Maat and Konings, 2018; Shi et al., 2019).

Through internet experiences and the attitude of travel convenience, three sociodemographic factors including age, incomes, and educational levels have similar impacts on online purchase frequency. As displayed in Figure 3, they have positive associations with the number of years using the internet (i.e., internet experiences). This means that older respondents and those who have higher incomes and higher educational levels tend to have a long history of using the internet, which is a reasonable finding. Meanwhile, internet experiences are negatively associated with the attitude of travel convenience, which is somewhat surprising. A possible explanation is that people having a long history of internet use might be more skilled and have a higher tendency to extend their search spaces for intangible services online. Consequently, they might travel farther to use these services, thus reducing the perceived ease of travel with online orders. Mediated by internet experiences, older respondents and those with higher incomes and higher educational levels are more likely to have a negative attitude toward the convenience of travel with online orders. Consequently, they purchase online less frequently.

Furthermore, age is directly and negatively associated with online purchase satisfaction & loyalty (see Figure 3 and Table 4). This means that younger people tend to feel more satisfied with online purchases, which may be attributed to their positive attitudes toward innovative products (Farag et al., 2006). Because of this, they are inclined to purchase more online. However, younger consumers may purchase less online because of the mediating effects of physical shopping accessibility. As indicated in Figure 3, age is negatively associated with accessibility to shopping centers. This implies that younger respondents tend to depart from areas with higher physical shopping accessibility for using services, possibly because they live or work there. Given the negative association between accessibility to shopping centers and the attitude of purchase satisfaction & loyalty, younger respondents are less likely to feel satisfied with online purchases. In view of this, they may purchase less online, which is inconsistent with the path from age to online purchase frequency through internet experiences and travel convenience. Nonetheless, online purchases are still more common among younger people, because the total effects indicate that age is negatively related to online purchase frequency and share (see Table 4). This is in line with previous findings (e.g., Ding and Lu, 2017; Maat and Konings, 2018; Zhou and Wang, 2014).

According to Figure 3 and Table 4, incomes also have direct effects and indirect effects through the built environment on online purchases. On the one hand, a direct and negative link between incomes and online purchase share is found, showing that – compared to low-income people – those with higher incomes tend to make fewer

online purchases. The possible reason is that low-income people have more liking for online services due to the relatively low prices of online services (Rotem-Mindali, 2010). On the other hand, incomes are positively associated with accessibility to shopping centers and street density. This implies that wealthy people tend to depart from areas with higher purchase accessibility and higher street density for traveling to use services, possibly because they have the affordability to live in these areas. Given the links between accessibility to shopping centers, the attitude of purchase satisfaction & loyalty, and online purchase frequency and share, wealthy consumers are less likely to purchase online. Apparently, purchasing intangible services online is likely a common phenomenon among low-income groups in Beijing. This finding is consistent with previous studies (Shi et al., 2019).

As shown in Figure 3 and Table 4, direct and positive associations of educational levels with online purchase frequency and share are found. This means that well-educated people are likely to purchase more online. Notably, as mentioned above, online purchase frequency is indirectly and negatively influenced by educational levels through the internet experiences and the attitude of travel convenience. Nonetheless, well-educated consumers tend to purchase more online according to the total effects (see Table 4), which is in line with expectations and previous results (e.g., Zhen et al., 2018; Zhou and Wang, 2014).

Student status is found to be indirectly correlated with online purchase frequency through internet experience and the attitude of travel convenience. As shown in Figure 3 and Table 4, students are likely to have a longer history of using the internet, which is in line with previous findings (e.g., Kirby-Hawkins et al., 2019). Meanwhile, students tend to have a negative attitude toward the convenience of travel with online orders. This seems reasonable in the Chinese context. This study focuses on intangible services. In particular, dining out services are most frequently purchased online according to our survey data. In China, three-meal services are provided every day on most university campuses, which means that students often have high proximity to dining services. In contrast, they must travel farther to use services when purchasing online (Shi et al., 2020a). Therefore, they may hardly find it convenient to travel to use services ordered online. Finally, mediated by internet experiences and the attitudes of travel convenience, students are less likely to purchase online frequently.

653 Table 4 Summary of standardized direct effects, indirect effects, and total effects

Variables	Online purchase attitudes						Online purchases					
	Travel convenience			Purchase satisfaction & loyalty			Frequency			Share		
	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total
Sociodemographics												
Gender (Female=ref.)	-0.141***	–	-0.141***	–	–	–	–	-0.017***	-0.017***	-0.080**	–	-0.080**
Age	–	-0.032***	-0.032***	-0.073*	0.005**	-0.069	–	-0.008***	-0.008***	–	-0.012*	-0.012*
Income	–	-0.019***	-0.019***	–	-0.007**	-0.007**	–	-0.003***	-0.003***	-0.105***	-0.010**	-0.115***
Education	–	-0.013***	-0.013***	–	–	–	0.066**	-0.002***	0.064**	0.189***	–	0.189***
Student status (Non-student=ref.)	-0.107***	-0.010**	-0.117***	–	–	–	–	-0.014***	-0.014***	–	–	–
Years of internet use on PCs	-0.094***	–	-0.094***	–	–	–	–	-0.011***	-0.011***	–	–	–
Online purchase attitudes												
Travel convenience	n/a	n/a	n/a	n/a	n/a	n/a	0.121***	n/a	0.121***	–	n/a	–
Purchase satisfaction & loyalty	n/a	n/a	n/a	n/a	n/a	n/a	0.063*	n/a	0.063*	0.179***	n/a	0.179***
Built environment												
Accessibility to shopping centers	–	n/a	–	-0.064*	n/a	-0.064*	–	-0.004*	-0.004*	–	-0.012**	-0.012**
Accessibility to metro stations	–	n/a	–	–	n/a	–	-0.064**	–	-0.064**	–	–	–
Street density	–	n/a	–	–	n/a	–	–	–	–	-0.135***	–	-0.135***
Employment density	–	n/a	–	–	n/a	–	–	–	–	0.069*	–	0.069*

654 Note: "*" p<0.10; "**" p<0.05; "***" p<0.01; "–" insignificant links (p>0.10); "n/a" not applicable.

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5 Conclusions and policy implications

Using data derived from 717 interviews in Beijing (China) in 2015 and focusing on intangible services, this study revealed the effects of the built environment on online purchases with consideration of the mediating role of online purchase attitudes. The analysis indicates that online buying of intangible services likely makes consumers travel more frequently to consume these services. The more consumers purchase services online, the more likely they increase the number of consuming trips. The SEM analysis further suggests that people having positive attitudes toward online purchases have a greater use of online purchases. Employment density is directly and positively associated with online purchases, while accessibility to metro stations and street density has a direct and negative effect on online purchases. Additionally, accessibility to shopping centers is negatively related to online purchase attitudes. As a result, the accessibility to physical purchase opportunities has an indirect and negative effect on the likelihood of buying online.

Roughly speaking, highly urbanized areas can be characterized by high levels of employment density, accessibility to public transit and to physical purchase opportunities, and street density. The positive relationship between employment density and online purchases may support the innovation diffusion hypothesis postulating that purchasing online is a more common phenomenon in urban areas. In contrast, the negative associations of accessibility to metro stations, accessibility to shopping centers, and street density with online buying may confirm the efficiency hypothesis stating that buying online is more common in weakly urbanized areas. In sum, both hypotheses seem to have explanatory power for the behavior of buying intangible services online. This is consistent with previous studies (e.g., Hood et al., 2020; Kirby-Hawkins et al., 2019; Shi et al., 2019).

As argued before, only statistical association is not sufficient for causal inference. A reasonable causal mechanism can add values to help infer causality (Handy et al., 2005; Singleton and Straits, 2005). The present study reveals the mediating effects of online purchase attitudes, which provide a possible explanation for the causal direction from the built environment to online purchases. Therefore, to some extent, the causal direction is strengthened. Meanwhile, online purchases of intangible services tend to make consumers travel more frequently and farther and decrease the use of active travel modes, therefore generating additional pressure on transportation systems. In view of this, it can be argued that urban planning strategies (i.e., built environment interventions) might be useful to reduce online purchases to cope with this induced transportation challenge. Specifically, like traditional policy recommendations, improvements in accessibility to physical purchase opportunities and transport facilities can effectively alleviate non-active travel demand resulting from online purchases of intangible services.

Notably, reducing employment density may not be a desired strategy in the context of Beijing, although it is helpful to alleviate the need for online buying of services. In Beijing, employment opportunities are mainly concentrated in the city center. Because

of the overpopulated land use in the main urban areas, reduction in employment density often means a spatial decentralization of employment functions from the city center to the city fringe. However, Jun (2020) supposed that – in cities with high population density (e.g., Beijing) – polycentric planning strategy (mostly dominated by employment decentralization) tends to result in longer commute time. Hu et al. (2018) even provided direct empirical evidence confirming that decentralizing employment opportunities to the city fringe in Beijing does lead to longer commutes, thus incurring additional transport demand. To moderate online purchase demand for services, a compromised strategy is – particularly in areas with high employment density – to optimize the accessibility to transport facilities (e.g., street networks, metro stations) and increase the provision of intangible services.

In addition, caution is needed regarding the contextual (geographic) heterogeneity when transferring policy recommendations from the case study of Beijing to other cities or regions. As mentioned before, Beijing is a megacity with high population density, severe transportation issues, and substantial internet-based consumption. Therefore, the policy recommendations in the present study may be more applicable to cities with similar characteristics (e.g., Shanghai, Guangzhou, Tokyo). Particularly in regions or cities with a high level of informatization (e.g., Chinese cities) there often exists a great use of online purchases leading to considerable effects on travel. Land-use strategies for managing online buying behavior will be more effective to alleviate travel demand.

Like online purchases of intangible services, some online activities may also have negative impacts on transportation systems. When buying intangible services online, consumers can acquire massive service information, and their search spaces for service information are largely extended. This is the essential factor driving an increase in their travel demands and the use of non-active modes. In reality, online activities such as searching on Dianping.com and Baidu Maps (in China) and on TripAdvisor and Google Maps (outside China) can help extend individuals' search spaces for destination information. Hence, such activities may also lead people to travel more frequently and farther by non-active modes (Shi et al., 2021a). However, it remains unknown whether and how the built environment impacts these online activities. This could be a future research direction.

Moreover, some potential issues need to be considered when land-use strategies are implemented to reduce travel demands caused by online buying of intangible services. First, as discussed before, buying tangible goods online may have different impacts on transportation systems. Meanwhile, the built environment may influence online purchases of tangible goods differently. Therefore, policymakers need to also consider the consequences of land use strategies for e-shopping for tangible goods and its transport effects. Second, implementing built environment strategies to mitigate non-active travel demands caused by online buying of intangible services may lead to a revenue loss for service providers. Economic costs need to be carefully balanced with transportation issues. Third, some selection bias possibly exists when recruiting respondents, which may lead to biased estimation outcomes. In particular, consumers having higher purchase demand may be overrepresented to some extent. This means

742 that the travel impacts of buying services online may be somewhat overestimated.
743 Additional empirical research with a well-representative sample is called for to verify
744 the generalization of findings in the present study.

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Highlights

(1) Purchasing intangible services online tends to increase non-active travel demands;

(2) The built environment has direct effects on online purchases;

(3) The effects of the built environment on online purchases are mediated by attitudes;

(4) Land-use policies are valid to manage online buying behavior for intangible services.