



# A Study on Vulnerability of Local Neighborhood Stores through the Concept of Resilience

## : Focusing on Online Shopping\*

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### Abstract

This study aimed to identify the factors affecting the vulnerability and resilience of Seoul's neighborhoods by analyzing the recent commercial resilience of social changes such as online shopping. Commercial resilience was defined as 'the ability to absorb the impact of online shopping and adapt to change', and the demographic and commercial characteristics that affect the use of online shopping were analyzed. Thereafter, the factors affecting commercial resilience have been integrally analyzed. According to this study, regional differences exist in online shopping practices, and regional population, social characteristics, and physical and commercial characteristics have a combined effect. In addition, the analysis showed that the retail ratio of neighboring commercial districts negatively affects commercial resilience. Finally, it was confirmed that population density, land use diversity, and income, which are closely related to the revitalization of the commercial district, have no influence on the resilience to the impact of online shopping, or rather have the opposite result. Today's online shopping causes a great crisis for the neighborhood, and the neighborhood needs to be fundamentally reinvented to survive. According to the results of this study, the conversion of neighborhood centers into food and service industries is irreplaceable for online shopping. Neighborhood centers provide leisure, social cohesion, and resilience to the local community. The future of these neighborhoods depends on appropriate urban planning and urban design issues.

**Keywords** Online Shopping, Resilience, Neighborhood Center, Vulnerability  
**주제어** 온라인 쇼핑, 리질리언스, 근린상권, 취약성

## 1. Introduction

The development of ICT and artificial intelligence (AI) because of the 4th Industrial Revolution has led to explosive growth of online shopping and delivery platforms, and the latest distribution industry, dubbed Retail 4.0, has greatly affected commercial spaces in cities and urban structures alike. According to Statistics Korea's Monthly Online Shopping Survey, the value of domestic online shopping transac-

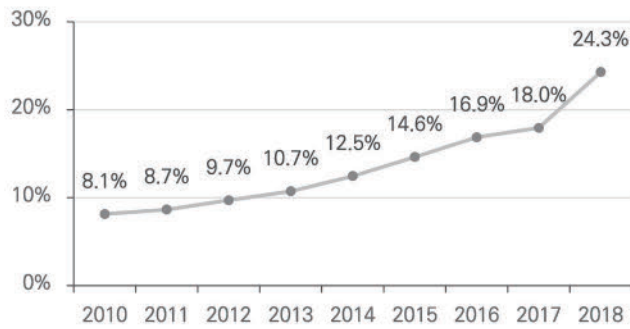
tions, which amounted to 3 trillion won in 2001, amounted to 113.7 trillion won in 2018, an increase of approximately 38 times. Online shopping transaction value vis-à-vis retail sales volume was investigated and found to have increased from 8.1% in 2010 to 24.3% in 2018 (see <Figure 1>). In particular, the share of online shopping transactions has increased greatly since 2015, and the stabilization of logistics innovation such as Rocket Delivery (Coupang, 2014) and Dawn Delivery (Market Kurly, 2015) has been pointed out as the

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\* Online shopping transactions include travel, culture, food, and other services

**Figure 1.** Trends in the proportion of online shopping transactions

main cause (KOTI Logistics Brief, 2019).

With such an expansion of online shopping, the number of neighborhood supermarkets (general retailing in spaces measuring 165 m<sup>2</sup> or less) has decreased from 76,043 in 2011 to 51,943 in 2018, or 31.7% (Statistics Korea Service Industry Survey, 2019), and some quantitative studies have reported a significant influencing relationship between an increase in online transactions and either a decrease in the number of retail stores (Lee, 2019) or a decrease in retail stores' sales volume (Jung and Sung, 2016).

In contrast, despite such this crisis for neighborhood commercial districts (neighborhood centers) due to online shopping, some studies have focused on both anchor stores, which are difficult to digitalize, and the low online substitution ratios of the leisure and service industries (Weltevreden, 2014), claiming that there are differences in effects of online shopping according to retail type (Parker and Weber, 2013). In addition, Rousseau (2009) has stated that flexible neighborhood commercial districts respond to external impacts such as online shopping and economic crisis and change in their roles. Dolega and Lord (2020) have argued that neighborhood commercial districts can respond to the crisis through a strategy that takes into consideration the economic levels of their visitors.

Neighborhood commercial districts' decline due to and responses to above-mentioned external impacts such as online shopping can be explained through the concept of resilience. Meaning recoverability, the concept of resilience can be interpreted as engineering resilience, ecological resilience (ecological recoverability), and adaptive resilience. Among these, adaptive resilience emphasizes the forms of systems and the reconfiguration of functions to minimize the effects of impacts and focuses on flexibility as a dynamic

and evolutionary process. Such adaptive resilience helps to interpret adaptive growth in relation to changes in the external environment such as the effects of online shopping on traditional neighborhood stores (Singleton et al., 2016). Consequently, this study seeks to elucidate more resilient characteristics of neighborhood commercial districts by interpreting these commercial districts' responses to online shopping through the concept of adaptive resilience.

## II. Literature Review

The non-geographical nature of online shopping requires the expansion of the existing concept of retail spatial structures in urban spaces. In existing discussions on spatial structures (Lee, 2012), which stress aspects such as the prosperity of higher-order central places, inertia in spatial structures, and transportation costs, it is difficult to explain urban retail spaces newly formed by both changes to retail locations due to online shopping and the service and food industries, which are difficult to replace online.

Consequently, this study seeks to analyze the latest changes in neighborhood commercial districts by examining traditional retail location theories and analyzing online shopping-related studies and the concept of commercial resilience (retail resilience).

### 1. Retail location theories

Though major theories explaining retail locations were devised in the 1930s, they are treated as important even today (Reigadinha et al., 2017).

First, Christaller's central place theory explains the sizes, distribution, and number of urban central places' hierarchical relations in an economy where consumers with identical incomes and preferences possess complete information and make rational decisions on a homogeneous unbounded plain (Kim, 2011). Explained through transportation costs, the central place theory predicts that the greater the distance from a central place is (i. e., the more transportation costs increase), the more demand for particular goods or services will decrease (Brown, 1993). A sphere in which the distance from a central place grows increasingly so that transportation costs and benefits from goods become identical is defined as a market sphere. The more an area is a



high-order central place, the larger the area of the market will be and the more diverse the services and goods provided will be (Kim, 2011). Christaller has explained the formation of central place hierarchies in cities through the principles of high-order central places and subsumption.

Contrary to the central place theory, according to which consumers are supplied with necessary goods and/or services from the nearest central place, where transportation costs become minimal, Reilly's (1931) spatial interaction theory and law of retail gravitation are based on a balance between attractive shopping spaces that serve as alternatives and the attenuating effect of distance (Brown, 1993; Reigadinha et al., 2017). Reilly has interpreted human behavior related to retail activities through the use of Newton's law of universal gravitation, demonstrating that the size of a central place is proportionate to the population and inversely proportionate to the square of the distance (Sung, 2018).

Next, Hotelling's (1929) principle of minimum differentiation has become a basis of microscopic research on retail locations (Brown, 1994; Reigadinha et al., 2017). Hotelling hypothesizes a market based solely on the supply price (product price + shipping cost) amid equal demand and fixed transportation costs. Two retailers supplying the same goods to this market come to sell those goods at the same prices in the center of the market (Reigadinha et al., 2017). If and when a new retailer enters this market, it may settle down in a place near the two other businesses because of its wishes for as large a market as possible, and if and when increasingly more retailers enter this market, they will exhibit a tendency to cluster (Reigadinha et al., 2017).

Traditional theories have thus viewed store density, including transportation costs (Christaller), population density (Reilly), and business type agglomeration (Hotelling), as an important element of retail locations.

## 2. Research on online shopping

In recent years, research on the effects of online shopping on retailing has proceeded. Mokhtarian (2002) has summarized the effects of information and communications technology (ICT) on physical passage, including shopping, using four concepts.

First, substitution signifies the replacement of actual shopping by online shopping, and many positivistic studies have

demonstrated substitution due to online shopping (Cubukcu, 2001; Bhat et al., 2003; Calderwood and Freathy, 2014). As for the latest studies, one by Xi et al. (2020) has analyzed the effects of online same-day delivery service on neighborhood shopping behavior in Nanjing, China, through the ordered logit model. According to the results of the analysis, the higher the frequency of online shopping is, the lower the frequency of using neighborhood stores is.

Complementarity is divided into enhancement and efficiency (Weltevreden, 2007). Enhancement occurs when online shopping directly affects or facilitates physical shopping, and efficiency consists of cases in which physical shopping increases the efficiency of online shopping, such as ordering items online and retrieving the ordered items at physical stores. Because, in these cases, shipping costs due to online shopping need not be paid, online shopping can be more attractive to certain consumers. While it is worth theorizing the complementarity of these two types, it is difficult actually to separate and explain them (Weltevreden, 2007).

Modification signifies changes to the duration, means of transportation, or destinations of shopping trips due to online shopping, and neutrality is a concept in which online shopping does not affect physical shopping.

Subsequent studies have pointed out online shopping as a major cause changing traditional central commercial streets (Singleton et al., 2016; Wrigley and Lambiri, 2014). In addition, they have reported that online shopping greatly decreases the number of trips outside the home potentially for consumer activities (Weltevreden, 2007) and predicted that, as a result, movement patterns within cities would change (Crocco et al., 2013; Pettersson et al., 2018).

However, though studies on changes to commercial districts and urban spaces due to online shopping have been conducted, research investigating local characteristics in terms of online shopping has hardly been conducted (Ren and Kwan, 2009). In addition, the effects of local factors either are unclear or have been underestimated (Cao et al., 2013; Farag et al., 2006). Many of the studies have focused mostly on sociodemographic characteristics affecting online shopping behavior, especially age, gender, and income (Fuchs, 2009; Song et al., 2020). Related studies have reported mixed results (Rotem-Mindali and Weltevreden, 2013; Song, Z., 2022) regarding the innovation hypothesis, according to which young urban residents living in areas



with high transportation accessibility use online shopping very much (Weltevreden, 2007; Farag et al., 2006), and the efficiency hypothesis, according to which residents living in low accessibility areas prefer online shopping because of the Internet's function of compressing time and space (Weltevreden and Van Rietbergen, 2009).

Meanwhile several studies have elucidated the characteristics of neighborhood commercial districts that do not decline despite the effects of online shopping. Dolega and Lord (2020) have shed light on the fact that while neighborhood commercial districts in impoverished areas in Liverpool underwent decline, those in affluent areas exhibited vacancy rates far lower than the national average. In addition, Singleton et al. (2016) have elucidated that commercial districts in large cities such as London show a high level of flexibility despite online shopping. Common characteristics of these studies is that the areas in question are higher-order central places with strong economic power, and that the consumers are oriented not toward retailing but toward new functions such as leisure and convenience.

### 3. Resilience

As has been mentioned above, online shopping, which has no restrictions in terms of time, distance, or location, has affected neighborhood commercial districts greatly. However, there are limitations to explaining the effects with the major variables of traditional location theories such as transportation costs, population density, and store density. Characteristics of online shopping that thus act as impacts on retail systems in cities can be explained using the concept of resilience, which signifies recoverability.

Using the concept of resilience to quantitatively examine changes in a system due to unforeseen external impacts, Holling (1973) has defined it as “the continuity of relationships within a system” and “the persistence of systems and their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables” (Kim et al., 2016). Because his engineering resilience focuses on the state of equilibrium after a system has recovered from impacts, and stresses the ability to return to a previous location or state, it is interpreted as resisting change (Barata-Salgueiro and Cachinho, 2021).

However, in the case of ecosystems, they adapt to impacts

by changing instead of returning to the state before the rise of impacts (Holling, 2001). Researchers have conceptualized this as ecological resilience (Gunderson and Holling, 2002; Rao, 2019). Meanwhile, whereas avoiding transitions in systems themselves amid changes is the heart of ecological resilience, human systems are maintained generally through the formation of new systems (Folke, 2006; Walker and Salt, 2012; Rao, 2019). Consequently, research in the social sciences has defined resilience not as a concept of the continuity of current systems but, rather, as a capacity for change (Martin, 2012). Such adaptive resilience as that defined by Martin (2012) signifies the ability of human systems to continue through new systems while maintaining a strong ability to adapt to changes (Rao, 2019). Using the complex systems theory, this concept focuses on analyzing the dynamic processes through which impacted areas adapt to such impacts with the passage of time, instead of measuring systems' recoverability (Martin, 2012; Barata-Salgueiro and Cachinho, 2021). Consequently, in the social sciences, the concept of adaptive resilience has been mainly applied (Barata-Salgueiro and Cachinho, 2021) and, under this concept, commercial resilience has focused on reducing vulnerability and interpreting methods of adapting to impacts. In other words, commercial resilience, using the concept of adaptive resilience, has been defined as the ability of retail systems to absorb impacts without failing to perform their functions in sustainable ways (Barata-Salgueiro and Erkip, 2014; Fernandes and Chamusca, 2014; Rao, 2019).

Specifically, the concept of commercial resilience was first used in 2011 by Wrigley and Dolega; these researchers analyzed how the functions of neighborhood commercial districts were changing due to the impacts of elements such as the global economic crisis. As for analysis, the influencing factors of commercial resilience were derived by examining changes in the commercial business type composition before and after impacts and using the concept of adaptive resilience. Commercial resilience was defined as the “vulnerability of commercial districts to the impacts of economic crises” and, with the use of changes in commercial vacancy rates as a proxy variable, regression analysis was performed. According to the results of the study, it was confirmed that retailing decreased and the food and service industries increased after the impacts, and the areas' low economic levels or high shares of retail stores increased vul-



nerability due to the impacts, thus lowering commercial resilience.

Subsequently, studies analyzing commercial resilience in North America (Rao and Summers, 2016; Rao, 2019), Europe (Singleton et al., 2016; Guimarães, 2018; Guimarães, 2019), and China (Rao, 2019) have used methods including case studies, interviews, and literature reviews, all applying the concept of adaptive resilience. In particular, Singleton et al. (2016) defined the vulnerability of neighborhood commercial districts to the impacts of online shopping as e-resilience. Using the degree of local residents' online exposure (demand) and local stores' supply vulnerability index (supply), they derived e-resilience and analyzed the characteristics of commercial districts that are vulnerable to the impacts of online shopping.

In recent years, research that makes use of the concept of commercial resilience to respond to a drastic decrease in face-to-face social activities and damages to urban retailing due to coronavirus disease 2019 (COVID-19) and to new contagious diseases that can arise in the future has been conducted as well (Ha and Lee, 2021).

Based on a review of earlier research, this study has defined commercial resilience as the ability to absorb the impacts of online shopping and to adapt to changes from the perspective of adaptive resilience; it was conducted with reference to the e-resilience index from Singleton et al. (2016).

#### 4. Contribution to this paper

many studies have demonstrated the substitution of neighborhood commercial districts by online shopping. Nevertheless, research has been scarce on the influencing relationship between neighborhood commercial districts' vulnerability to online shopping and consumers' tendencies. Despite evidence implying relations between factors affecting the use of online shopping and demographic and socioeconomic characteristics (Longley and Singleton, 2009), research has been limited on the geography of online shopping (Forman et al., 2009; Singleton et al., 2016).

In addition, commercial resilience has hardly ever been applied to explorations of how retail systems may respond to online retailing (Singleton et al., 2016; Rao, 2019). Research has been conducted mainly through the use of methodologies such as in-depth interviews, case studies, and

policy change examinations.

When all of the above is synthesized, the commercial characteristics of commercial districts such as sociodemographic characteristics and business types can become factors capable of affecting not only commercial locations but also the use of online shopping as impacts. Nevertheless, research examining them integratively has been scarce. Consequently, this study is differentiated by analyzing the sociodemographic and commercial characteristics that affect the use of online shopping and then integratively analyzing factors that affect commercial resilience.

### III . Framework of Analysis

#### 1. Scope and methodology

this study seeks to elucidate the characteristics of neighborhood commercial districts that are resilient despite recent impacts of online shopping by examining traditional location theories, online shopping, and the concept of resilience.

The progression of this study is as follows. First, the demographic and commercial characteristics affecting the use of online shopping are derived, and then factors affecting commercial resilience are analyzed.

The spatial scope of this study is Seoul and, as for the units of analysis, units of alley commercial districts in the service of analyzing the commercial districts of neighborhood stores provided by the Seoul Credit Guarantee Foundation were used. As for the temporal scope, it was set in the period from 2016 to 2018, during which online shopping had great effects (see <Figure. 1>) and for which data usable for analysis were available.

The objects of this study were commercial districts on the lowest hierarchy, instead of specialized ones (Berry, 1963), and were residential area-centered neighborhood commercial districts that were distant from central places and saw residents' daily and frequent trips (Ballantyne et al., 2022). Consequently, this study was conducted after excluding the following from alley commercial data provided by the Seoul Credit Guarantee Foundation: central places such as Myeong-dong, which are difficult to see as neighborhood commercial districts as defined in this study; specialized commercial districts concentrated with businesses such as light-



ing supply stores, meat stores, private academies (cram schools), and hospitals; and areas where commercial business types and hierarchies had changed due to the commercialization of residential areas.<sup>1)</sup> The IQR method was used to select the study areas, and outliers were eliminated on the basis of business types, the numbers of stores, the workplace population vis-à-vis the residential population, the floating population, and commercial districts' sales volume. As for the final objects of this study, 660 neighborhood commercial districts in Seoul were selected, as in <Figure 2> below:

## 2. Data sources

As for the online shopping-related data in this study, data on card consumption pattern per business type from the Seoul Big Data Campus were processed and used. Card owners' payments per business type, provided by Shinhan Card (debit cards and credit cards), were estimated in consideration of the use of cards from other companies and then added up per block and analyzed.<sup>2)</sup> Excluded from estimation were both business types unrelated to consumer

activities such as taxes, utility fees, and wholesaling, and company credit cards. This study used the data, presented in units of blocks, by integrating them in units of commercial districts, and used the share of e-commerce business type in card payments vis-à-vis total business types for residents per commercial district as online shopping data.

Next, as for data on sales volume per commercial district, the Seoul Credit Guarantee Foundation's data on sales volume per commercial district were used. As for sales volume per commercial district, the share of sales volume per business type and the correction rate per card company were estimated from sales volume data provided by BC Card, Kookmin Card, and Shinhan Card; card companies' block-level materials per business type were added up into commercial district-level materials. In this study, commercial districts' sales volumes for a total of 48 business types encompassing 26 retail business types, 12 service business types, and 10 food business types were derived and research was conducted. The business types used in this study were as in <Table 1>. In addition, as for other factors related to sociodemographic characteristics such as the population

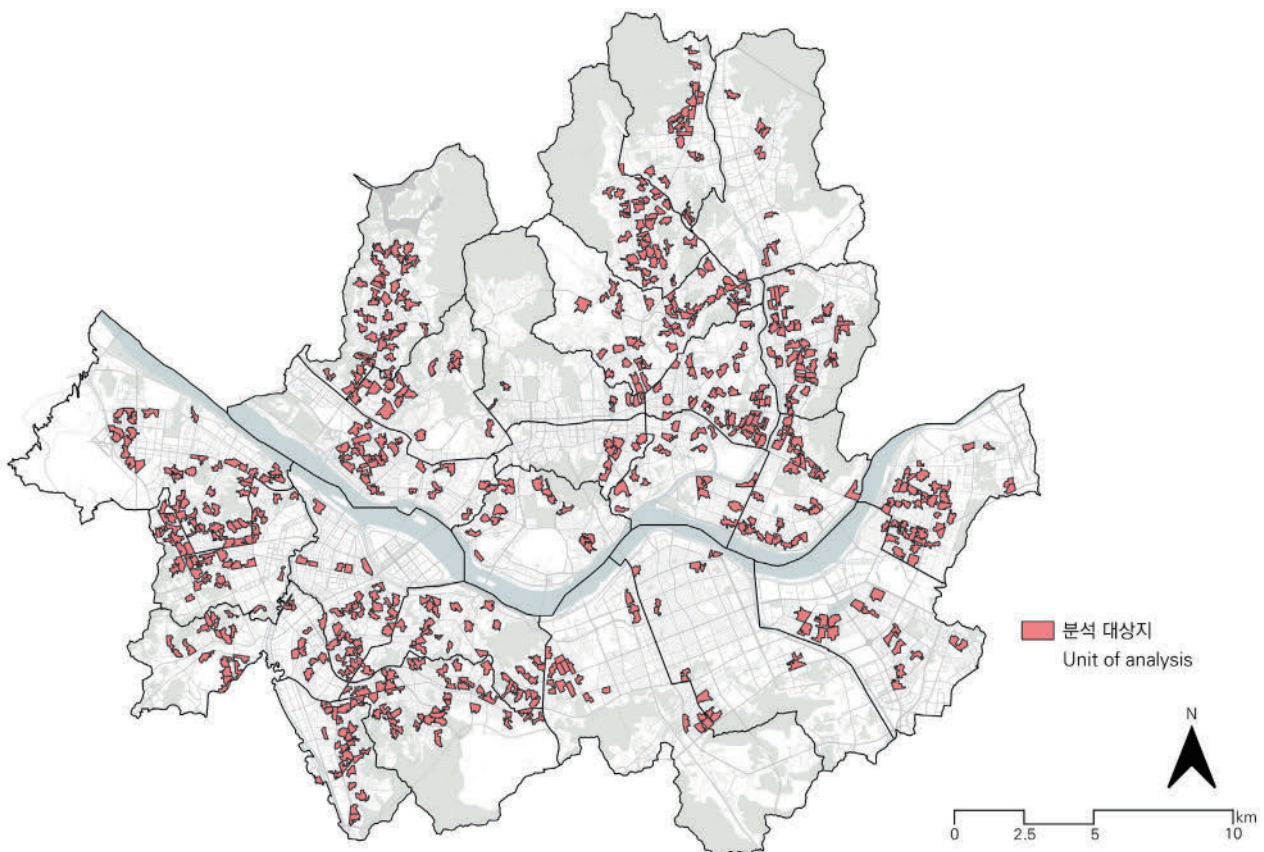


Figure 2. Study area



density, shares of the population by age and gender, average number of household members, worker density, share of apartments, average monthly income, store density, share of retail stores, and franchise store density, the Seoul Credit Guarantee Foundation’s data were used as well. For land use diversity, integrated geographic information system (GIS) building information materials from the Korea National Spatial Data Infrastructure Portal, which are based on information on building register attributes, were used; distances to subway stations, super-supermarkets (SSMs), and hypermarkets were constructed using materials from the electronic map database (DB) of the Ministry of the Interior and Safety.

### 3. Measures

In this study, commercial resilience was defined as the ability to absorb impacts of online shopping and to adapt to changes; commercial resilience index was derived through the process of Equation (1) below:

$$resilience^i = \ln\left(\frac{s_{2018}^i / s_{2016}^i}{\bar{o}^i}\right) \tag{1}$$

As for the resilience index, it was set as changes in the sales volume ( $s$ ) of commercial district  $i$  vis-à-vis the average share of e-commerce business type payment ( $\bar{o}$ ) by a resident of the commercial district. By using this to analyze changes in the sales volume vis-à-vis the impacts of online shopping, the area’s commercial resilience was measured.

Variables were constructed as in <Table 2> below, in consideration of land use characteristics and accessibility characteristics in addition to sociodemographic characteristics and commercial characteristics, which affect commercial resili-

ence.

In this study, to perform an analysis of the influencing factors of commercial resilience, transportation costs, population density, and store density from traditional, earlier, location theories were used first, and, in the case of store density, it was differentiated into store density and the share of retail stores and used in the analysis to explain the effects of online shopping. In addition, as for demographic characteristics as influencing factors of commercial resilience, population density was turned into a variable on the basis of the law of retain gravitation and, because there were differences in the use of online shopping according to age, gender, and number of household members, these characteristics were added as explanatory variables. According to the National Information Society Agency’s (NIA) *2020 Survey on the Internet Use* (2020), the shares of Internet shopping users were high in the age groups of 20s (94.7%), 30s (93.8%), and 40s (86.3%), and the shares for the age groups of 50s, 60s, and 70s or above amounted to 60.2%, 31.4%, and 14.7%, respectively, thus showing that the share of Internet use decreased greatly starting in the age group of 50s. In addition, as for gender, the share of Internet shopping users was higher for females (71.8%) than for males (68.2%). Meanwhile, a study of the United Kingdom by Clarke et al. (2015) derived the result that males in their 20s-30s earning high incomes and living in cities had a high probability of using online shopping, thus exhibiting differences from the situation in South Korea.

In addition, as demographic factors capable of affecting commercial districts’ sales volume, worker density (Lee and Sung, 2020; Sung, 2022) and the income of the population living in commercial district hinterlands (Kang, 2019) were turned into variables. In addition, because apartments can affect the availability of neighborhood commercial districts

**Table 1.** Types of retail business

Type	Sub-type
Retail	Luggages, Grains, Textiles, Fishery products, Watches and jewellery, Footwear, Meat, Clothing, Vegetables, Fruit and root crops, Cosmetics, Stationery, Side dishes, Books, Supermarkets, Musical instruments, Eyeglasses, Pet animals and pet supplies, Pharmaceutical and medical goods, Communication equipment, Flowers and plants, Household equipment, Bicycles and other transportation equipment, Lighting equipment, Hardware, Computers, Convenience stores
Restaurants	Light food, Western food, Japanese food, Bakeries, Coffee shops, Non-alcoholic beverages places, Chinese food, Chicken restaurants, Take-out light food, Korean food, Taphouses
Personal services	Nail salon, Hair beauty shops, Photographic studio, Household laundry services, Sports club, Skin beauty shops, Sports and recreation education, Cultural education, Foreign language institutes, Clinics, Dental hospitals, Oriental medical clinics

**Table 2.** Variable description

Variables		Description	Sources	Time period	
Dependent variable	Online shopping (A)	Share of card payment amount of e-commerce business to total business type	Seoul Big Data Campus	2016-2018	
	Index of retail resilience	Change in sales in commercial districts compared to e-commerce payment share (A)	-		
Independent variable	Demographic	Population density	Population density of neighborhood and hinterland (persons/10,000 m <sup>2</sup> )	Seoul Credit Guarantee Foundation	2016
		Share of the population in 20s to 40s	Share of the population in 20s to 40s in neighborhood and hinterland		
		Share of population by gender	Share of female population in neighborhood and hinterland		
		Ave. no. household member	Average number of household members in the neighborhood and hinterland (Num. Population/Num. Households)		
		Worker density	Density of office workers in neighborhood (persons/10,000 m <sup>2</sup> )		
		Share of apartment	Share of apartments in the hinterland		
		Ave. monthly income	Ave. monthly income in the hinterland		
	Land use	Land use mix (LUM)	Land use mix for the main purpose of the building (residential, commercial, business, public, cultural, etc.)	Korea National Spatial Data Infrastructure Portal	
	Retail	Store density	Number of small businesses in the neighborhood (units/10,000 m <sup>2</sup> )	Seoul Credit Guarantee Foundation	
		Share of retail stores	Share of retail businesses		
Share of franchise store		Share of franchise store			
Accessibility	Subway	Distance to nearest subway station	Ministry of the Interior and Safety		
	SSM	Distance to nearest SSM			
	Hyper-mart	Distance to nearest hyper-mart			

(Kim and Park, 2020) and are related to households' life cycles, household sizes, and assets, apartments were turned into variables. In the case of commercial characteristics, in addition to the commercial density and the share of retail stores, mentioned earlier, the share of franchise stores was turned into a variable. This was because, in many cases, franchise business type use the multi-channel sales method, where both offline and online channels are used, more than do general independent stores.

Next, in the case of land use characteristics, land use diversity was used. As for land use diversity, the six uses of housing (detached housing; communal housing), commercial

use (neighborhood living facilities types 1 and 2; sales facilities), business use (business facilities; transportation facilities; warehouse facilities), public use (public facilities; educational, research, and welfare facilities; educational and research facilities), cultural use (cultural and assembly facilities; lodging, sports, recreational, and religious facilities), and others on the basis of the main uses of structures were measured by using the entropy formula (Jung et al., 2015; Sung, 2022), and diversity was greater, as the figure shows.

Finally, to explain transportation costs, subway accessibility was established as a proxy variable, and SSM accessibility and hypermarket accessibility were used as variables, which



greatly affected domestic retailing in the past. Accessibility was measured as the linear distance from the central place of a neighborhood commercial district to the nearest representative of each facility.

#### 4. Model selection

To examine the factors influencing online shopping (model 1) and those of the integrative commercial resilience (model 2) as impacts, this study conducted multiple regression analysis.

According to the results of Pearson correlation analysis, the share of apartments exhibited high correlation with both the average number of household members (0.58) and the average monthly income (0.44). These results seem to reflect domestic housing characteristics and life cycle characteristics, where apartments are preferred as the number of household members increases and income increases. Consequently, the share of apartments was excluded from the analysis.

In addition, in order to grasp the presence or absence of spatial autocorrelation, global Moran's I analysis was performed. Because, in this study, boundaries among commercial districts were not contiguous, the reciprocal distance

matrix method was used instead of the contiguity weight, and, according to the results, Moran'I value turned out to be 0.1 or below, thus confirming low spatial autocorrelation.

Next, to perform a test of the independence of residuals, the Durbin-Watson test was performed. According to the results of the test, the online shopping model and the commercial resilience model showed values of 1.94 and 2.11, respectively, exhibiting figures close to 2 and thus confirming the non-existence of autocorrelation. In the case of the homoscedasticity of residuals, it was confirmed through a scatter plot of predictors and residuals (Montgomery et al., 2021), and both analytical models turned out to satisfy the homoscedasticity hypothesis.

## IV. Results

### 1. Summary statistics

The share of online shopping as an impact on the 660 neighborhood commercial districts that were the objects of analysis, the spatial distribution of commercial resilience, one variable of interest, was confirmed, and the following summary statistics were confirmed for an understanding of variables to be used in this study (see Table 3). First, the

**Table 3.** Summary statistics

Variables		n	Mean	Std. dev.	Min	Max	
Dependent variable	Online shopping	660	0.146	0.015	0.079	0.230	
	Index of retail resilience	660	6.629	0.260	4.520	7.812	
Independent variable	Demographic	Population density (log)	660	6.083	0.286	4.489	6.640
		Share of the population in 20s to 40s	660	0.480	0.042	0.384	0.674
		Ratio of female population	660	0.504	0.016	0.397	0.561
		Ave. no. household member (log)	660	0.809	0.114	0.315	1.127
		Worker density (log)	647	4.329	0.737	2.547	6.026
		Share of apartment	660	0.181	0.154	0.001	0.837
		Ave. monthly income (log)	660	15.075	0.163	14.711	15.612
	Land use	Land use mix (LUM)	660	0.434	0.154	0.058	0.859
		Store density (log)	660	2.496	0.537	0.647	3.482
	Retail	Share of retail stores	660	0.354	0.108	0.033	0.893
		Share of franchise store	660	0.225	0.103	0.000	0.604
	Accessibility	Subway (log)	660	6.265	0.544	4.530	7.695
		SSM (log)	660	6.425	0.712	3.550	8.275
Hyper-mart (log)		660	6.957	0.588	4.531	8.229	



online shopping variable, which signified the share of card payments in e-commerce vis-a-vis the total business types, yielded a mean of 0.15 and a standard deviation (SD) of 0.01, respectively. In the case of the commercial district with the greatest share of online shopping, 23% of total card payments was used for online shopping. When examined through the distribution map in <Figure 3>, the outskirts of Seoul, such as the southwestern and northeastern areas of the capital, used online shopping comparatively less, and the share of use of online shopping increased as area became closer to the downtown. Consequently, the use of online shopping as an impact on neighborhood commercial districts was confirmed to differ per location of the commercial district.

Next, in the case of the commercial resilience index, the mean and SD were 6.62 and 0.26, respectively, and the commercial district with the greatest vulnerability to the impacts of online shopping was analyzed to amount to 4.52. When the distribution of commercial resilience in <Figure 4> is examined, the closer a store was to the downtown, the

comparatively more it was vulnerable; however, compared with the distribution of online shopping in <Figure 3>, local characteristics were confirmed to be comparatively unclear.

## 2. Analysis of factors influencing online shopping

the results of the analysis of the factors influencing online shopping were as in <Table 4>, below. According to the results of the analysis, the innovation hypothesis and the efficiency hypothesis reviewed in earlier research turned out to be at work in a complex manner and, out of them, value  $\beta$  of the sociodemographical characteristic variables, which are innovation hypothesis variables, turned out to be higher than the values of commercial characteristic and accessibility, which are efficiency hypothesis variables; thus, the effects of the innovation hypothesis are greater, according to this analysis.

When the variables are examined individually, first, in the case of sociodemographic characteristics, according to the analysis, the greater the share of the population in their 20s-40s was, the greater the income was, and the smaller the number of household members was, the more online shopping was used. In particular, the share of the population in their 20s-40s exhibited the largest  $\beta$  value (0.325) out of all variables, thus making it possible to confirm the presence of the greatest effects. The reason for this can be interpreted thus: in the case of comparatively young populations, they are used to online shopping (2020 Survey on the Internet Use, 2020), so that the bulk of their retail activities, including the purchase of daily necessities, occurs through online channels rather than neighborhood commercial districts. Such results considerably matched the results of research supporting the innovation hypothesis (Clarke et al., 2015; Lee, 2018).

Next, as a land use characteristic, land use diversity turned out not to be statistically significant for use in online shopping, despite the existence of its comparatively clear positive (+) influencing relationship with offline commercial districts' sales volume (Kang, 2016; Sung, 2022). This seems to stem from the non-geographic attributes of online shopping, which differs from existing physical retailing. Nevertheless, in relation to the efficiency hypothesis, it was possible to confirm that the lower the store density was and the

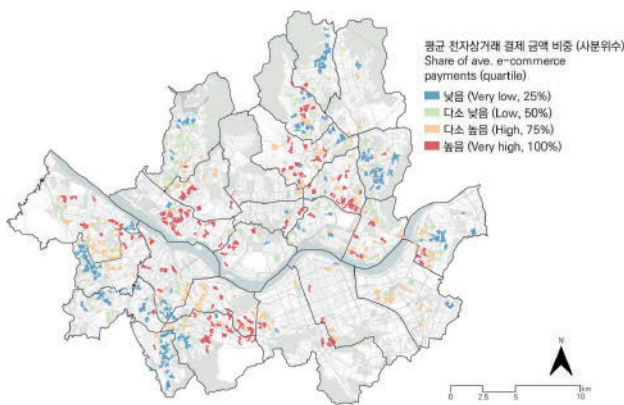


Figure 3. Share of ave. e-commerce payments

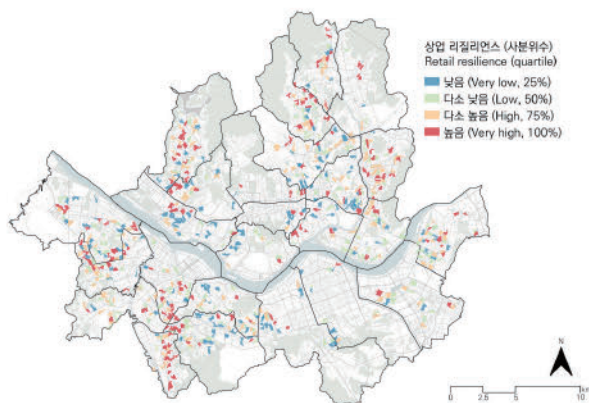


Figure 4. Retail resilience



**Table 4.** Result of Regression (online shopping)

Variables		Coef.	Std. err.	$\beta$	t-value	VIF
Demographic	Population density (log)	0.001	0.002	0.025	0.624	1.516
	Share of the population in 20s to 40s	0.119***	0.017	0.325	6.971	2.024
	Ratio of female population	0.041	0.039	0.042	1.057	1.455
	Ave. no. household member	-0.013*	0.007	-0.096	-1.934	2.321
	Worker density (log)	0.001	0.001	0.053	1.237	1.721
	Ave. monthly income (log)	0.024***	0.004	0.249	6.244	1.482
Land use	Land use mix (LUM)	0.004	0.004	0.037	0.922	1.525
Retail	Store density (log)	-0.002**	0.001	-0.086	-2.259	1.360
	Share of retail stores	0.006	0.005	0.040	1.141	1.150
	Share of franchise store	0.012**	0.006	0.082	2.255	1.244
Accessibility	Subway (log)	-0.002**	0.001	-0.080	-2.182	1.238
	SSM (log)	-0.001	0.001	-0.044	-1.203	1.268
	Hyper-mart (log)	0.002**	0.001	0.068	1.976	1.117
Constant		-0.283***	0.059	-	-4.809	-
<i>adj. R<sup>2</sup></i>				0.293		
<i>N</i>				660		
Durbin–Watson <i>d</i> value				1.935		
<i>F(p)</i>				22.022***		

\*\*\*p<0.01, \*\*p<0.05, \*p<0.1

greater the distance to the nearest hypermarket was, the more positive (+) effects there were on the use of online shopping. This implies that the lower accessibility to commercial facilities is, the more consumers use online shopping, signifying that physical environments of cities in relation to online shopping must be taken into consideration more closely (Farag et al., 2006; Weltevreden and Rietbergen, 2009).

The share of franchise stores exhibited a positive (+) influencing relationship on the use of online shopping. In the case of franchise stores, they are likely to proceed with sales not only offline but also online and, in the online consumption of daily necessities, the locations of franchise stores close to residential areas can increase online consumption, and this presumably stems from the complementary characteristics of online shopping described earlier. Finally, the distance from the nearest subway station was analyzed and found to have a negative (-) influencing relationship on the use of online shopping. Because the share of the use of online shopping is comparatively low on the outskirts of cities, as in (Figure 3), this can be seen as matching the results

of the innovation hypothesis.

### 3. Analysis of factors influencing commercial resilience

defining commercial resilience as the “ability to absorb the impacts of online shopping and to adapt to changes,” this study turned it into an index of “changes in a commercial district’s sales volume vis-à-vis the impacts of online shopping” and conducted analysis. The results of the analysis in this study are as in (Table 5). First, in the case of population density, which is importantly treated in location theories as well, though a negative influencing relationship with sales volume has been reported recently (Kang, 2019; Sung, 2022), it is generally expected to have a positive relationship with commercial districts’ sales volume (Choi and Shin, 2001). Though the results of this study, which analyzed commercial resilience in consideration of the impacts of online shopping, derived a negative (-) coefficient value, as did recent research, it was not statistically significant. As is also apparent from the results of an analysis of factors influencing



**Table 5.** Result of Regression (retail resilience)

Variables		Coef.	Std. err.	$\beta$	t-value	VIF
Demographic	Population density (log)	-0.002	0.042	-0.003	-0.058	1.516
	Share of the population in 20s to 40s	-0.975***	0.325	-0.159	-3.001	2.024
	Ratio of female population	0.902	0.735	0.055	1.227	1.455
	Ave. no. household member	0.015	0.130	0.006	0.112	2.321
	Worker density (log)	-0.012	0.017	-0.033	-0.672	1.721
	Ave. monthly income (log)	-0.237***	0.072	-0.149	-3.286	1.482
Land use	Land use mix (LUM)	-0.037	0.077	-0.022	-0.481	1.525
Retail	Store density (log)	0.072***	0.021	0.148	3.428	1.360
	Share of retail stores	-0.233**	0.096	-0.097	-2.431	1.150
	Share of franchise store	-0.132	0.105	-0.052	-1.260	1.244
Accessibility	Subway (log)	0.047**	0.020	0.099	2.386	1.238
	SSM (log)	0.002	0.015	0.005	0.121	1.268
	Hyper-mart (log)	0.014	0.017	0.033	0.829	1.117
Constant		9.813***	1.123		8.737	
<i>adj. R<sup>2</sup></i>				0.091		
<i>N</i>				660		
Durbin–Watson <i>d</i> value				2.118		
<i>F(p)</i>				6.047***		

\*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$

online shopping in Section 2, rather than population density as a simple demographic characteristic, more specific influencing factors such as age, income, and household size seem to have been at work in response to impacts.

Next, as an age characteristic, the share of the population in their 20s-40s exhibited negative (-) correlation with commercial resilience; this can be interpreted as showing that the more a comparatively young population lives in a hinterland, the more the commercial district is vulnerable to the impacts of online shopping. Such results seem to stem from the fact that consumption by the young population, who are relatively more skilled at online shopping, occurred online instead of through the areas' neighborhood commercial districts. Likewise, the average monthly income had a negative (-) influencing relationship on commercial resilience. In particular, in the case of income, despite common reports of its positive effects on commercial districts' sales volume (Sung and Choi, 2017; Kim and Lee, 2019; Kang, 2019), it exhibited the opposite results. This can be understood as showing that income in commercial districts' hinterlands is an important factor increasing commercial dis-

tricts' sales volume and, on the contrary, capable of bringing about even more vulnerable results to impacts of online shopping.

In the case of commercial characteristics, store density had a positive (+) correlation with commercial resilience. High store density can increase the probability of consumers' multi-purpose, complementary, and comparative shopping (Sevtsuk, 2020), and it was possible to confirm that the physical agglomeration of such stores had positive effects on not only commercial districts' sales volume (Kang, 2019) but also resilience. In contrast, the share of retail stores was analyzed and found to have a negative (-) correlation, which matches the results of existing research (Wrigley and Dolega, 2011). Adaptive resilience can be understood as a dynamic process of changing into a new form or function after impacts, and the results of this study can be seen as the results of neighborhood commercial districts' process of self-organization and adaptation to online impacts.

Finally, the distance from the nearest subway station exhibited a positive (+) correlation, thus showing that the closer a store was to a subway station, the more vulnerable



to impacts it was. This matched the results of earlier analysis that the closer a consumer was to a subway station, the more he or she used online shopping.

## V. Conclusions

This study sought to confirm factors affecting the vulnerability and resilience of neighborhood commercial districts in Seoul by quantitatively analyzing commercial resilience to social changes in recent years, such as online shopping.

Devised in the 1930s, traditional location theories have the advantage of being able to interpret complex urban spaces more effectively through transportation costs as well as population and commercial density; however, they have limitations in examining goods and services on the same hierarchy and taking into consideration the effects of online shopping due to the development of ICT.

In the early 2000s, diverse studies were conducted with a focus on changes to urban spaces due to online shopping. Distinguishing between goods (retailing) and services (service and food industries), unlike the case of location theories, these studies claimed that retailing, which provided goods, would be substituted by online shopping and that this could threaten the survivability of cities in the long term. In contrast, a small number of studies, focusing on changes to the roles of neighborhood commercial districts, argued that commercial districts that had turned to the leisure and service industries could prosper despite the impacts of online shopping.

Since 2010, the concept of resilience, signifying recoverability from impacts, was introduced. It was further reduced to the concepts of urban resilience and commercial resilience, which were used as ways of understanding social impacts and adaptation processes. In particular, as a process for understanding the evolution of retail systems after threats or impacts, the resilience of neighborhood commercial districts can help to maintain and to improve commercial districts in terms of policy as well as socially and economically (Barata-Salgueiro and Erkip, 2014).

Consequently, this study used both commercial location theory per era and the concept of resilience to analyze neighborhood commercial districts in Seoul. While numerous studies related to commercial resilience were qualitative or declaratory studies consisting of expert interviews or

comparisons of related laws, due to limitations such as data, this study quantitatively analyzed neighborhood commercial districts' resilience to gradual impacts such as online shopping and changes to population structures, and herein lie its differentiating points.

The major results of this study are as follows. First, the study confirmed the existence of local differences in the use of online shopping and elucidated that the sociodemographic characteristics and physical/commercial characteristics of areas were at work in a complex way. In particular, it derived the fact that sociodemographic characteristics, related to the innovation hypothesis, had greater effects on the use of online shopping than did physical/commercial characteristics, related to the efficiency hypothesis. Second, the share of retail stores in neighborhood commercial districts was confirmed to have negative effects on commercial resilience. This can be interpreted through both the reduction of retailing due to online shopping and the expansion of the leisure and service industries. Such business type characteristics signify that neighborhood commercial districts improve in resilience the more they turn to the service industry or the food industry, rather than playing the role of retail suppliers before the rise of online shopping. It was possible to confirm that neighborhood commercial districts' resilience was not engineering resilience, where recovery to past levels is made, but was closer to adaptive resilience, with spaces playing new roles. Finally, population density, land use diversity, and income in hinterlands, which are closely related to commercial districts' activation, were confirmed to have no effects on or to bring about results opposite to resilience to the impacts of online shopping. Consequently, it is necessary to review commercial districts' vulnerability and resilience to impacts more closely in analyses and policies for commercial activation.

Traditionally, neighborhood commercial districts in cities not only satisfied demand for various products and services but also guaranteed easy access and, as a form of public good, contributed to the sustainability and healthy lifestyles of local communities as well (Rao and Summers, 2016; Sandercock and Dovey, 2007; Zukin, 2009). Today, however, online shopping has created a great crisis for neighborhood commercial districts, and it is necessary for neighborhood commercial districts to be recreated fundamentally for survival. As in the results of this study, neighborhood commer-



cial districts' reduction in retailing and transition to the food and service industries not only are irreplaceable by online shopping but also provide local communities with leisure, social cohesion, and resilience. In addition, the recent spread of a contactless culture due to COVID-19 has provided new discussions on the functions of central business districts (CBDs) and the central place paradigm (Hillier, 1997), and neighborhood commercial districts in areas, as spaces of diversity, can become spaces with the potential to embrace the functions of CBDs in the past (Carmona, 2022). Such a future of neighborhood commercial districts leaves both urban planning tasks such as the distribution of facilities including those for leisure, work, housing, and urban logistics and the maintenance of retail accessibility through walking and urban design tasks as a result of changes to neighborhood commercial districts' physical landscapes and travel behavior (Kickert, 2022). Neighborhood commercial districts can provide opportunities to create better areas and, ultimately, to build better cities (Sevtsuk, 2020), and this is therefore the time for paradigm shifts and integrative commercial plans in urban planning and design that can embrace them.

Though this study only analyzed neighborhood commercial districts in residential areas, immense changes today can affect the spacial structures and landscapes of both commercial/business areas and entire cities. In addition, the recent introduction of urban logistics facilities called dark stores can greatly affect the landscapes of and trips in neighborhoods. Consequently, it is necessary to conduct follow-up research in consideration of diverse variables capable of affecting urban spatial structures. In addition, this study was limited in analyzing dynamic changes in commercial districts due to its comparatively narrow temporal scope. Necessary in the future are examinations of dynamic changes in commercial districts from the perspective of resilience.

Note 1. Alley commercial districts provided by the Seoul Metropolitan Government target concentrated residential areas where 30 or more business types closely related to daily life exist. (<https://golmok.seoul.go.kr/introduce.do>)

Note 2. Business types are provided through differentiation into dining/entertainment, distribution, food, clothing/miscellaneous goods, sports/culture/leisure, travel/transportation, beauty, home life/services, education/private academies, medicine, home appliances/furniture, automobiles, refueling, and e-commerce.

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