Analysis of Daily Living Sphere Considering Population Movement Characteristics

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Abstract

In this study, centrality analysis and cohesion analysis were conducted among social network analysis methods after processing and constructing an OD matrix for external and internal movement of the working population in Gyeongsangnam-do based on mobile travle data provided by SKT base station. In the analysis of degree centrality, external migration was high in Gimhae-si, Yangsan-si, and Changwon-si, and internal migration in the province, it was high in Changwon-si and Gimhae-si, Haman-gun, showing that it has more potential. The results of the betweenness centrality analysis were high in the case of external migration in Seoul, Jeju Special Self-Governing Province, Sejong Special Self-Governing Province, and Gangwon-do, and internal migration in the province, it was high in Changwon, Jinju, Haman-gun, and Gimhae-si. The results of the eigenvector centrality analysis were high in Gimhae-si, Yangsan-si, and Busan Metropolitan City for external migration, and internal migration in the province, Changwon-si, Gimhae-si, and Haman-gun showed high eigenvector centrality. Until now, most of the urban district plans have been discussed for the purpose of strengthening the spatial structure and competitiveness of metropolitan cities. This study is significant in that it looked at commuter traffic zones at the level of local small and medium-sized cities and derived a new planned execution space unit called commuter traffic zones for the workplace population. In the future, it can be considered as a basic reference indicator in promoting regional plans at the urban level.

Keywords: Movement Pattern, Big Data, Centrality Analysis, Living Sphere

1. Introduction

Population concentration in large cities is efficient and effective in achieving nationwide economic growth; however, it can also lead to negative consequences such as regional imbalances (Rahimi et al, 2020). Such population movements simultaneously induce an increase in the population at the destination and a decrease in the population at the departure point, ultimately causing spatial imbalance (Aljoufie et al, 2011; De Vos and Witlox, 2013). Therefore, regions experiencing population concentration show positive impacts, such as regional economic development. Conversely, regions experiencing population dispersion face negative impacts, such as urban decline and urban extinction (Kim, 2020). The concentration of employment and economic activities in large cities, as well as the deepening disparity in the utilization of transportation and service infrastructure, seem to be rooted in this context (Rezende amara et al, 2015).

Dual-service infrastructure is a crucial facility that contributes to the quality of urban life and economic development. It represents one of the desired elements for residents in creating an ideal living environment (Doyle and Havlick, 2009). However, when it comes to service infrastructure, it typically depends on private initiatives, which require a suitable urban scale for the functioning of facilities. In other words, not only the population size but also lower traffic volumes in small to medium-sized cities may result in a shortage of service infrastructure resources compared to larger cities. Most residents in a given area prefer to have access to high-order central functions near their residence. However, due to a lack of service infrastructure resources in the local area, there are instances where residents move to other regions to access the required services. In this context, the regional imbalance of service infrastructure resources can worsen the concentration of population in large cities.

In this study, our objective is to differentiate between the two main types of mobility: short-distance movements within a region and long-distance movements that cross administrative boundaries. By doing so, we aim to understand movement patterns and regional characteristics based on the purpose of travel. Specifically, we aim to explore whether population movements within and outside the city, which appear to impact the placement of low-order and high-order service facilities, are connected to the levels of purposeful travel occurring in the region. Therefore, the objectives of this study can be summarized in the following three points. Firstly, the study aims to understand the characteristics of purposeful travel networks at a regional level. Secondly, the study aims to identify patterns of inter-regional interactions within each network. Thirdly, the study aims to elucidate the relationship between internal (short-distance) and external (long-distance) purposeful travel networks using geographical spatial accessibility metrics derived from population movements between origin and destination regions.

To achieve this, the study aims to analyze the interconnections between regions based on the purpose of travel using Social Network Analysis methods. Through the method of Social Network Analysis, the study aims to focus on the relationships between actors rather than individual characteristics. It measures relationships and flows between pivotal points to understand the characteristics of the network. In general, a network consists of nodes, links, and components. Nodes, also known as vertices, represent the actors in the network, while links signify the relationships between actors. Components refer to connected subsets of nodes, which are essentially subgroups that make up the network. The reference year for the analysis is 2019, and the primary spatial unit for the analysis is the 250 administrative districts (si/gun/gu) of South Korea. Therefore, each administrative district serves as a node in the network, where population movements are interconnected.

2. Literature Review

2.1. Central Place Theory and Network Theory

A prominent study on the hierarchy of cities is Christaller's Central Place Theory (1993). In this theory, a "central place" refers to an area that provides a range of goods and services to the surrounding region, known as the "hinterland." The hinterland is the area that receives these supplies from the central place. In this theory, the concept of a "threshold" is introduced to explain the minimum requirements necessary for maintaining a city's central place. It suggests that the scale of a city can determine the goods or services it provides, highlighting the idea that the hierarchy of a city is ultimately determined by its size and the functions it offers. By the mid-20th century, the explanatory power of central place theory weakened as lower-order cities witnessed the rise of high-level industries, including knowledge-based manufacturing and high-order services. This departure from the traditional concentration of high-order industries in high-density areas challenges the explanatory capability of central place theory (Camagni, 1993).

To explain this phenomenon, one can turn to the theory of Network City. The term "network" refers to a collection of interconnected nodes, based on the structuralist notion that "nothing exists in isolation from anything else" (Barabasi, 2002). Networks demonstrate a dynamic structure created by the interaction of their components and the overall network structure. The concept of networks, which originated from the natural sciences, was applied to social phenomena through Giddens (1984) and specifically through the Theory of Structuration.

From this perspective, let's examine the key characteristics of Central Place Theory and Network Theory. According to Batten (1995), who highlighted the distinctions between Central Place Theory and Network Theory, Central Place Theory establishes the hierarchy of cities based on the central place, with these central places being ranked by scale. This implies that regions in lower hierarchies are subordinate to regions in higher hierarchies, and higher-hierarchy regions have a corresponding level of importance. Therefore, higher and lower cities establish a vertical accessibility relationship. Additionally, in Central Place Theory, the cost of travel in a homogeneous space is considered a significant expense. In contrast, Network Theory considers nodality as a crucial factor, placing more emphasis on the organic relationships between cities rather than the size of the regions. Therefore, it is based on the mutually complementary characteristics of cities in a more flexible context. In other words, it emphasizes connectivity (horizontal accessibility) between cities on a horizontal plane rather than a vertical hierarchy among them. Additionally, within a network system that deals with various goods and services, it operates under the assumption of an imperfect competitive market characterized by variations in products and prices. Consequently, factors such as information costs become crucial in this context.

While Central place theory is based on scale and rooted in spatial concentration due to external effects, Network theory is not necessarily contingent on spatial concentration (Suarez-Villa and Rama, 1996). This characteristic leads to the recognition in Network City Theory that cities provide distinct functions through their individual specializations, and in some cases, high-order functions may be provided even in lower-order cities (Capello, 2000).

Central Place Theory and Network Theory are discussed from different perspectives. However, many studies still utilize both theories to explain city hierarchy, typology, and related phenomena. Neal (2011) categorized cities into three main patterns based on their size and network hierarchy. Cities with a significant size-based hierarchy and a strong network foundation are referred to as "primary cities." Those with high size but a limited network are termed "offline metropolises," while areas with low size but a strong network are called "wired towns." "Primary cities" are not only sufficiently large in scale but also have a significant nationwide impact. These primary cities can be considered as cities belonging to the top tier in terms of both size and network hierarchy (Jefferson, 1939). However, it's important to note that not all cities with large scales necessarily have a well-established network infrastructure. So-called "offline metropolises" are characterized by their large scale within the city but a lack of an established network infrastructure, resulting in isolation from external regions. These cities tend to exhibit various local issues in areas such as transportation, crime, and the environment (Short, 2004). In other words, Giddens' (1984) assertion in the Theory of Structuration that "structure is both the medium and the outcome of the reproduction of practices" can be explained by the dynamic nature of change brought about by network elements and structures.

2.2. Application of Network City Theory

In studies that apply Central Place Theory, the focus is often on empirically analyzing how the functions of regions are shaped differently in high-order central places with large scales and low-order central places with small scales, based on the regional hierarchy. In the majority of studies validating Central place theory, population has been used as a proxy variable to measure city size in research. In this regard, Berry and Garrison (1958) proposed that functions with a tendency to appear in large central places can be considered as advanced functions (Functional Quality: FQ)." Building on this, they considered functions to be more advanced when the minimum market size for each function, known as the 'threshold,' is larger. Using a similar concept, Ullman and Dacey (1960) developed a formula that relies on the population size of a region to determine the minimum employment ratio for various industries in that region This can be seen as a method that assumes that, depending on the population size of a region, there exists a minimum employment ratio required for each industry. Although the specific methodologies may vary across studies, the common thread is the idea that the function of a city, determined by its size (i.e., population), determines the functions the city possesses.

In contrast, empirical studies to understand the effects of network dynamics have been conducted relatively recently.

Batten (1995) conducted a preliminary study on network cities, with a specific focus on the Randstad region in the Netherlands. This region includes cities such as Amsterdam, Rotterdam, The Hague, and Utrecht. This study focused on the network based on functional specialization among cities, suggesting the possibility of achieving global competitiveness through collaboration among relatively small-sized cities. In an empirical analysis of Network City Theory, Meijers (2007) examined its effects. The study aimed to analyze the relevance of network theory in the healthcare and higher education sectors in the Netherlands. Specifically, it focused on the potential of Network city theory to address issues such as the lack of scale in healthcare facilities located in the hinterland and high healthcare costs. The study proposed that mutual complementarity among facilities could be a solution to these challenges. In a study by Neal (2011), which went beyond specific functions to understand the overall effects of network-based dynamics, empirical analysis from the perspective of urban regions in the United States demonstrated a shift in the urban hierarchy from Central place theory to a network-based approach. This study analyzed city functions using three factors: the number of industry employees, city size based on population, and network levels based on the number of air travelers. The study indicated a decrease in the effects based on scale since the 1940s, with a growing influence of network-based effects.

2.3. Research on Population Movement Networks

Population movement reflects the flow of interaction between regions, which is influenced by the functional differentiation of cities. Different types of movements are classified based on motivation, scope, and duration. The causes of population movement can be explained by pull factors and push factors. Attracting factors include elements such as quality employment and high wages, while emitting factors include low wages and a lack of cultural facilities. Population movement has been the subject of numerous recent studies, and researchers have investigated various cases related to migration patterns and characteristics of urban populations. (Geiger and Pécoud, 2013; Shen, 2012; Shumway and Otter-strom, 2009; Wright et al, 1997). In addition to statistical analysis, numerous studies have also examined the characteristics of population movement from the perspective of network theory. (Boyd et al, 2013; Wall and van der Knaap, 2011; Alderson and Beckfield, 2004; Smith and Timberlake, 2002; Mahutaga et al, 2010).

3. Research Framework

3.1. Data for Analysis

The population movement analysis in this study utilized Origin-Destination (O-D) data on passenger traffic between 250 cities and districts in South Korea, based on the 2020 Passenger Origin-Destination Survey. The passenger traffic data represents the estimated daily movement of people between specific origins and destinations, assuming consistent travel patterns. The Origin-Destination (O-D) data on passenger traffic for the year 2019, provided by the Korea Transport Database, is categorized based on the travel criteria into linked trips and unlinked trips. Linked trips are further segmented into seven categories based on the purpose of travel, including commuting, school attendance, business, shopping, returning home, leisure/entertainment/family visits, and others. Among these, this study specifically extracted and utilized shopping trip data to validate the central place theory and network theory mentioned in the theoretical review section.

Next, in order to analyze the relationship between shopping trips and travel distance, we utilized accessibility indices, which are also available in the Korea Transport Data Base. Accessibility indices do not explain actual travel; instead, they measure the ease of travel in terms of travel cost and the cumulative opportunities for engaging in activities. These indices are calculated based on travel time. The service facilities included in the accessibility indices are educational facilities, medical facilities, retail facilities, and public transportation facilities. In this study, only sales facilities, such as large-scale stores and traditional markets, were identified and used for analysis. Accessibility is measured using three indicators: average travel time, the proportion of the population with access, and the number of accessible facilities. The accessibility of individual regions can be measured relative to the national average level, indicating whether it is relatively favorable or unfavorable. Firstly, the average travel time was calculated to determine the time required to reach the nearest service facility in each city and district. Next, Accessible population ratio is a calculated value that indicates the proportion of the population in a given area who can reach specific service facilities within a specified time frame. Finally, the number of accessible facilities represents the average number of service facilities that can be reached within a specific time frame in each region.

3.2. Analysis Methodology

Quantitative understanding of population movement is crucial. However, it is also important to analyze the interconnected characteristics of movement between regions in order to examine the concentration or dispersion of population within a region. Especially, since interregional population movement involves complex flows with extensive connections, network analysis is essential for analyzing central areas. In this network analysis, various measures of centrality can be calculated for each region, including degree centrality, closeness centrality, betweenness centrality, and eigenvector centrality (Bonacich, 1987; Fiedkin, 1991; Wasserman and Faust, 1994; Borgatti, 2005; Carrington et al, 2005). Analysis of interregional movement network characteristics was conducted using SPSS and NetMiner software.

First, descriptive statistics (mean scores, standard deviations) were analyzed for regional internal and external movements related to shopping travels. Statistical significance was tested for travel volumes using one-way analysis of variance (ANOVA) and Tukey-b post hoc analysis (α=0.05). Next, an integrated network was created based on the 250 by 250 origin-destination (O-D) matrix. Network characteristics, such as size (number of nodes), average degree, concentration (degree centralization index), and diameter, were examined. Subsequently, an analysis of degree centrality at the node level was conducted to explore the key regions that play significant roles in the shopping travel network. Degree centrality analysis classifies connections into two types: in-degree centrality and out-degree centrality, based on the direction of relationships (Opsahl and Panazarasa, 2009).

$$C_D^w(i) = \sum_j^n w_{ij} \qquad (1)$$

Moreover, considering variations in shopping travel amounts based on regional characteristics, block modeling was conducted to explore interaction patterns at the regional level. Block modeling is a network analysis method that simplifies complex networks by grouping individual actors (nodes) with structural equivalence or similar social roles into clusters. This makes the network easier to understand. Matrix calculations are then employed as modeling tools to represent relationships between clusters (Wasserman and Faust, 1994). Clusters of actors, based on equivalent structures or roles, determine the positions within the network. Blocks represent these positions or roles. Finally, a quantitative regression analysis will be conducted to examine the relationship between the amount of shopping travel that occurs within regions and externally, and the accessibility indicators of sales facilities in each region.

4. Analysis Results

4.1. Descriptive Statistics of Shopping Travel Volume by Regional Size

The results of the analysis of variance for the average local internal shopping travel volume across regions are as follows. The F value for the shopping travel volume, based on the size of the region, is 87.11. The corresponding p-value is 0.000, indicating statistical significance at a significant level of 0.05. The average volume of internal shopping travel is 9.90 ± 0.80 for large cities, 9.51 ± 0.74 for medium-sized cities, and 7.74 ± 1.50 for small cities. Furthermore, the volume of internal shopping travel within large cities is significantly higher than that within medium-sized and small cities (c < a, b).

The results of the analysis of variance for the average regional external shopping travel volume are as follows. The F value for the shopping travel volume, based on the size of the region, is 30.75. The corresponding p-value is 0.000, indicating statistical significance at a significance level of 0.05. Furthermore, the average volume of external shopping travel is 5.59 ± 1.74 for large cities, 6.62 ± 1.58 for medium-sized cities, and 4.40 ± 1.78 for small cities. Additionally, it has been observed that the volume of shopping travel from medium-sized cities to external locations is significantly higher than that from both large cities and small cities (c < a < b).

The results of the analysis of variance for the average regional internal shopping travel arrival volume are as follows. The F value for the shopping travel arrival volume, based on the size of the region, is 72.13. The corresponding p-value is 0.000, indicating statistical significance at a significance level of 0.05. Furthermore, the average volume of internal shopping travel arrivals for large cities is 9.67 ± 1.11, for medium-sized cities is 9.50 ± 0.86, and for small cities is 7.68 ± 1.45. It is also noteworthy that the volume of internal shopping travel arrivals within large cities is significantly higher than that within medium-sized and small cities (c < a, b). This is consistent with the results of the internal shopping travel volume.

The results of the variance analysis for the average volumes of external shopping travel arrivals between regions are as follows. The F value for shopping travel arrivals based on the region's size is 83.34, and the corresponding p-value is 0.000, indicating statistical significance at a significance level of 0.05. Furthermore, the volume of external shopping travel arrivals in major cities was 6.53 ± 1.81, in provincial cities it was 5.31 ± 2.00, and in small to medium-sized cities, it was 3.39 ± 1.56. It is also noteworthy that the volume of shopping travel from major cities to external locations is significantly higher compared to both provincial cities and small to medium-sized cities (c < a < b).

Table 1: Shopping Purpose Travel Characteristics

	Internal shopping travel occurrence	External shopping travel occurrence	Internal shopping travel arrival	External shopping travel arrival
Metropolitan city (n=74)	9.90±0.80	5.59±1.74	9.67±1.11	6.53±1.81
Provincial metropolitan city (n=44)	9.51±0.74	6.62±1.58	9.50±0.86	5.31±2.00
Provincial small city (n=132)	7.74±1.50	4.40±1.78	7.68±1.45	3.39±1.56
F(p)†	87.11(0.000) c<a, b	30.75(0.000) c<a<b	72.13(0.000) c<a, b	83.34(0.000) c<b<a

4.2. Major Cities and Interconnectivity of the Shopping Travel Network

The internal shopping travel network under consideration consists of 250 nodes, including six transmitters, one isolated node, and 243 ordinary nodes. The average degree of the network is calculated to be 11.95, with a diameter of 6. This indicates the maximum distance between any pair of nodes. The degree centralization index reveals notable values: 28,970.19% for in-degree and 17,591.39% for out-degree.

The external shopping travel network consists of 250 nodes, including one transmitter and 249 regular nodes. The network has an average degree of 205.50 and a diameter of 2. This represents the maximum distance between any pair of nodes. The degree centralization index for this network is significant, measuring 3,874.60% for in-degree and 5,167.28% for out-degree. These findings provide insights into the structural characteristics and centrality of nodes within the internal shopping travel network.

Table 2: Characteristics of Internal and External Shopping Travel Network

	Internal shopping travel	External shopping travel
Size (number of nodes)	250 (Transmitter 6, Isolate 1, Ordinary 243)	250 (Transmitter 1, Ordinary 249)
Average degree	11.95	205.50

	Internal shopping travel	External shopping travel
Size (number of nodes)	250 (Transmitter 6, Isolate 1, Ordinary 243)	250 (Transmitter 1, Ordinary 249)
Diameter	6	2
Degree centralization index	28,970.19% for in-degree, 17,591.39% for out-degree	3,874.60% for in-degree, 5,167.28% for out-degree
Major cities	(in-degree) - Jung-gu, Daegu - Buk-gu, Daegu - Jung-gu, Busan - Busanjingu, Busan - Jung-gu, Seoul (out-degree) - Suseong-gu, Daegu - Dong-gu Daegu - Dalseo-gu, Daegu - Deokjin-gu, Jeonju-si, Jeollabuk-do - Gwangsan-gu, Gwangju	(in-degree) - Songpa-gu, Seoul - Bucheon-si, Gyeonggi-do - Yeongdeungpo-gu, Seoul - Jung-gu, Seoul - Dong-gu, Daegu (out-degree) - Gyeongsan-si, Gyeongsangbuk-do - Yangsan-si, Gyeongsangnam-do - Siheung-si, Gyeonggi-do - Gimpo-si, Gyeonggi-do - Guro-gu, Seoul

The block model matrix represents the structural relationship and connections between major cities in the shopping travel network. Each row and column correspond to a specific city, with entries indicating the presence (1) or absence (0) of connections between pairs of cities. Among the metropolitan cities, the most prominent shopping travel is observed to originate from Seoul and travel to other cities such as Daegu, Incheon, Gyeonggi, Chungnam, and Jeju. Additionally, shopping travel is observed to originate from Incheon, Gyeonggi, Gangwon, Chungbuk, Chungnam, and Sejong and arrive in Seoul. Notably, Ulsan and Incheon show a trend where the number of regions receiving shopping travel is less than those generating shopping travel, indicating active shopping travel to nearby regions. Gangwon Province shows relatively limited shopping and travel activity compared to other regions. Gyeonggi-do and Chungnam exhibit highly active shopping travel, surpassing other regions. Jeju Island demonstrates more outgoing shopping travel than incoming, suggesting a vibrant outbound shopping travel activity from Jeju. Ulsan and Incheon indicate a higher frequency of shopping travel generation compared to regions where shopping travel is less common.

This analysis reveals distinct patterns in shopping travel behavior that are influenced by the size and geographical location of the city. The findings emphasize variations in shopping travel activities, highlighting the importance of considering the size of urban areas and regional positioning when studying shopping travel patterns.

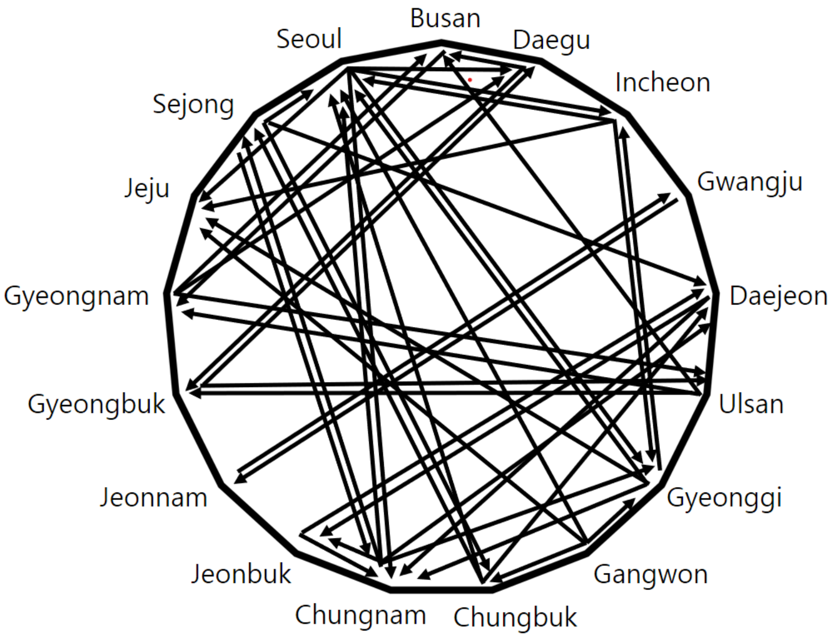

Figure 1: Block Modeling Analysis Results

4.3. Model Analysis Results

Table 3: Analysis of the relationship between facility accessibility and shopping travel volume

			Internal shopping travel occurrence			**External shopping travel occurrence**			**Internal shopping travel arrival**			**External shopping travel arrival**		
			B	**SE**	**β**	**B**	**SE**	**β**	**B**	**SE**	**β**	**B**	**SE**	**β**
intercept			7.574	1.497	-	0.843	2.585		6.087	1.619		-2.334	2.634	
Large-scale retail stores	**Average access time**		**-0.046*** **	0.013	-0.629	-0.005	0.023	-0.055	**-0.052*** **	0.014	-0.716	-0.016	0.023	-0.153
	Accessible population ratio	**Within 15min.**	0.001	0.006	0.017	0.011	0.010	0.248	0.002	0.006	0.046	0.004	0.010	0.081
		Within 30min.	0.004	0.007	0.087	-0.007	0.012	-0.150	0.003	0.007	0.083	0.007	0.012	0.115
		Within 45min.	0.003	0.008	0.068	0.016	0.014	0.259	-0.002	0.009	-0.030	-0.020	0.014	-0.282
		Within 60min.	-0.020	0.011	-0.299	-0.022	0.019	-0.260	**-0.024 ***	0.012	-0.343	0.004	0.019	0.045
	Number of accessible facilities	**Within 15min.**	0.021	0.035	0.050	-0.007	0.061	-0.014	0.057	0.038	0.133	**0.205 ****	0.062	0.345
		Within 30min.	0.082	0.056	0.229	-0.054	0.097	-0.122	0.005	0.061	0.015	-0.048	0.099	-0.095
		Within 45min.	-0.079	0.055	-0.196	**0.192 ***	0.095	0.389	-0.044	0.059	-0.108	-0.021	0.097	-0.036
		Within 60min.	-0.007	0.049	-0.013	0.024	0.084	0.039	-0013	0053	-0026	0.019	0.086	0.027
Small-scale retail stores	**Average access time**		-0.005	0.033	-0.028	0.038	0.056	0.166	0.035	0.035	0.189	**0.113 ***	0.057	0.434
	Accessible population ratio	**Within 15min.**	-0.006	0.007	-0.109	0.006	0.012	0.089	-0.001	0.007	-.018	0.007	0.012	0.094
		Within 30min.	**0.026 ***	0.011	0.312	-0.005	0.020	-0.049	**0.036 ****	0.035	0.421	0.028	0.020	0.234
		Within 45min.	**-0.082 ****	0.024	-0.607	0.008	0.042	0.049	**-0.076 ****	0.026	-0.562	0.016	0.043	0.083
		Within 60min.	**0.100 *****	0.020	0.641	0.013	0.035	0.069	**0.092 *****	0.022	0.584	0.007	0.036	0.034
	Number of	**Within**	0.001	0.035	0.002	-0.168	0.061	-0.349	0.028	0.038	0.070	-0.055	0.062	-0.099

			Internal shopping travel occurrence			External shopping travel occurrence			Internal shopping travel arrival			External shopping travel arrival		
			B	**SE**	β	**B**	**SE**	β	**B**	**SE**	β	**B**	**SE**	β
intercept			7.574	1.497	-	0.843	2.585		6.087	1.619		-2.334	2.634	
	accessible facilities	**15min.**												
		Within 30min.	0.004	0.043	0.011	**0.242 ****	0.075	0.470	-0.004	0.047	-0.008	0.128	0.076	0.216
		Within 45min.	-0.017	0.061	-0.030	**-0.161 ****	0.106	-0.226	-0.022	0.066	-0.038	0.026	0.108	0.032
		Within 60min.	0.012	0.089	0.014	0.176	0.153	0.171	0.088	0.096	0.104	0.105	0.156	0.089
Provincial metropolitan city			**-0.209 ****	0.094	-0.101	0.264	0.162	0.104	-0.069	0.102	-0.033	**-0.643 *****	0.165	-0.221
Provincial small city			**-0.221 ****	0.093	-0.210	-0.072	0.161	-0.056	-0.169	0.101	-0.160	**-0.569 ****	0.164	-0.385
F(p)			27.832***			8.197***			22.336***			13.465***		
adj. R^2			0.842			0.646			0.813			0.735		
Durbin-Watson			1.994			1.893			2.165			1.848		

$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

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