



## **Developing a Parcel Freight O-D and Identifying Parcel Freight Determinants for Seoul Metropolitan Area**

**Project Number: 16-1.1d**  
**Year: 2016**

**FINAL REPORT**  
**April 2018**

### **Researchers**

**PI: Sangbeom Seo**, Research Fellow, Logistics Research Department, the Korea Transport Institute (KOTI), Sejong, Korea

**Research members:**

**Changjin Ahn**, Doctoral Student, Dept. of Geography, Sungshin Women's University, Seoul, Korea

**Jee-Sun Lee**, Associate Research Fellow, Logistics Research Department, KOTI, Sejong, Korea

**MetroFreight Center of Excellence**  
**The Korea Transport Institute (KOTI), Sejong, Korea**

# **Title: Developing a Parcel Freight O-D and Identifying Parcel Freight Determinants for Seoul Metropolitan Area**

## **Abstract**

The Seoul Metropolitan Government has been interested in realigning the city logistics policy to develop the sustainable management strategies for the quality of parcel services in the City of Seoul. It is significant to understand the spatial pattern of parcel freight movement within the city for developing the appropriate strategies. This research aims at planning the city logistics policy and developing the sustainable management strategies for the parcel services of quality in the City of Seoul. In order to meet this research goal, this study begins first with constructing a parcel freight O-D matrix for the Seoul Metropolitan Area (SMA), and secondly, it conducts correlation and regression analyses in order to explore which factors influence the productions and attractions of parcel freight transportation within the SMA. Nineteen variables are selected out of four categories of socio-economic indicators related to population, industry, housing, and income to analyze, and the OD data of parcel freight flows transported by one of the major parcel service companies in Korea for 2013 are utilized. Analysis results show that parcel freight inflows are highly correlated with population, housing, and income indicators, while outflows are strongly correlated to industry indicators. This study concludes that each district (Gu) has its own socio-economic characteristics which affect the productions and attractions of parcel freight. It implies that city logistics policy needs to reflect each district's diverse socio-economic characteristics as well as their approach in a general view.

Keywords: parcel service, city logistics policy, socio-economic indicators, the City of Seoul

## **INTRODUCTION**

### **PROJECT OBJECTIVE**

#### **Purpose of study**

This study aims at planning the city logistics policy and developing the sustainable management strategies for the parcel services of quality in the City of Seoul. For the purpose of this research, the study starts at developing a parcel freight O-D matrix for the Seoul Metropolitan Area (SMA). Based on this parcel freight O-D, it tries to explore which factors influence the productions and attractions of parcel freight transportation within the SMA.

## PROJECT DESCRIPTION

### Background

Standard contract term of parcel services in Korea defines parcel services as the door-to-door logistics services that pick up small-sized and light items from each household, office, shop, or any places which the senders designate and then deliver the items to the designated place where the receivers are located such as home, office, shop, etc. Parcel service is a very labor-intensive logistics service: it encompasses a series of processes for pick-up and collection, interregional transportation, sorting, shipping and delivery so as to effectively and efficiently deal with various freight items produced almost everywhere in the city or region.

Teleshopping and e-commerce have accelerated the growth of the parcel service industry as one of the representative logistics industries in Korea. In 2013, 1.5 billion boxes of parcels had been dealt, which means each customer takes an advantage of parcel services to send 7.3 boxes a month on average (1). Its service is in various forms of C2C (customer to customer), B2C (business to customer), C2B (customer to business), and B2B (business to business), and it has become an indispensable logistics service of citizens' everyday life. However, diverse social problems such as traffic congestion, delivery accidents, and crime occur, since some infrastructural and institutional settings are not favorable to the parcel services of quality yet.

Although most customers (94.4% of respondents) surveyed are found to be satisfactory with parcel services, the measures to guarantee service of quality and safety of customers are still insufficient. According to the report of customer's complaints, 25.6% of customers had experienced damage to the item delivered whether it is major or minor (1). When specifying the damage types, delayed delivery, damaged and spoiled items, missing articles and wrong delivery account for 36.7%, 35.9%, and 21.1%, respectively (1). In addition, most of the women customers are reported to feel afraid to contact parcel delivery men: 62.2% of women who answered, expressed worry about some crime possibility when they contact the parcel delivery men during the course of pick-up and delivery (2). Seoul Metropolitan Government has initiated the safe parcel service project for female customers by installing unmanned parcel lockers. Although it has been introduced as the representative approach for crime-free parcel service by the public side, it is not evaluated as a long-term solution but a short-term expedient. In order to develop more sustainable, effective and efficient expedients for the parcel service of quality, it is significant for national and local governments to plan and implement exclusive policies that reflect their own urban and regional logistics environment. Therefore, it is most essential to understand socio-economic characteristics of each city and region in order to choose more appropriate urban and regional logistics policies.

This study aims at proposing necessary public policy and suggesting management strategies for the parcel services of quality. It explores the socio-economic factors by *Gu*, which is a medium-level administrative and spatial district, within the City of Seoul so as to understand which factors influence the productions and attractions of freight transportation by parcel service. Seoul has 25 *Gus*, and parcels shipped to, from and within this city explain 35.5% of the entire parcels shipped in South Korea. In exploring the socio-economic factors that

produce and consume parcel trips within Seoul, social indicators that OECD, TRB's NCFRP (National Cooperative Freight Research Program), and any other related research had applied are examined to select applicable socio-economic factors to describe the regional parcel service market conditions in a realistic manner. The factors are grouped as four categories: population-, urban industrial structure-, housing-, and income-related indicators. All socio-economic data is sourced from *Statistics of Seoul Metropolitan Government* (<http://stat.seoul.go.kr>) (3) and *Trend of Real Estate Market in Seoul* (4). The volume of parcels shipped by *Gu* is based on the parcel transportation OD data during 2013 which is provided by one of the major parcel service companies in Korea.

## Research review

While several studies on optimal logistics network and system planning for parcel service, consolidated logistics strategies for parcel pick-ups and deliveries, and introduction of eco-friendly trucks and transportation modes for parcel delivery have been undertaken, relatively little research on socio-economic factors that influence the market of parcel services in Korea have taken place.

Lee *et al.* suggested a pilot project to explore the shortest route for parcel delivery in the region of Yangyang-Gun in Korea (5), and Kim *et al.* recommended to build regional parcel service networks not by the logistics company itself but by collaborating with the manufacturer (6). As for eco-friendly parcel transportation, Song suggested green city logistics policy with a focus on renewal of the transportation system within the center of cities by introducing bikes instead of trucks as an alternative transportation mode and consolidation centers for last-mile shipping (7). Lee *et al.* also concluded that the consolidated parcel service center within an apartment complex is essential to reduce emissions, fuel use and transportation costs (8). Yu *et al.* emphasized city logistics policy to impose carbon emission cost on parcel services that produce enormous truck traffic within the city (9). Besides, the Seoul Institute has introduced several policy directions and strategies for sustainable city logistics of parcel services in the City of Seoul (10, 11). Nevertheless, relatively little attention has been paid to the approach to understand the influence of socio-economic factors on parcel service demands at the regional level, so that the region-specific city logistics plans and strategies to solve the existing challenges are limited to develop in Korea.

On the other hand, NCFRP analyzed the factors that influence freight transportation demands (12). However, it dealt with general cargo not parcels. Since parcel service is distinguished from general cargo freight, some exclusive factors are to be considered in understanding parcel freight productions and attractions. Still, this study adopted some of the indicators NCFRP employed to select socio-economic factors which can explain freight transportation exclusively for parcel services.

Anderson *et al.* presented a model and a case study to estimate freight OD based on socio-economic factors which determine freight transportation in small and medium sized communities (13). They examined several socio-economic indicators such as total households, household by income level, population size by category, employment size by industry, employment density, and area, and disclosed that manufacturing and retail employment sizes,

and the number of high income households are statistically significant as freight determinant factors. They developed a regression model with these three variables to explain truck traffic.

Devan examined the macro-economic factors that influence international parcel shipment (14). His study indicated that regulations on international e-commerce, political stability, oil prices, environmental and labor-related institutions by country determine the volume of international parcel shipment. It concentrated on identifying the reason for volume change of international parcel shipments rather than understanding the attributes to produce and consume parcel services in a region.

**TABLE 1 Socio-Economic Factors Applied to Determine Freight in Previous Studies**

OECD Social Indicator <sup>1</sup>	Anderson <i>et al.</i> (2013)	NCFRP(2011) <sup>2</sup>			
		Boilé & Golias (2006)	Liu & Kaiser (2006)	Lawrence & Kleinman (1993)	Black (1999)
<p>General Indicators:</p> <ul style="list-style-type: none"> <li>· Total population, Population growth rate, Old people ratio</li> <li>· GDP, GPD per capita, GNI per capita</li> <li>· Total tax burden, taxes and rates</li> <li>· Sustenance allowance (total, by age)</li> </ul>	<ul style="list-style-type: none"> <li>· Total households</li> <li>· Low income households</li> <li>· Medium income households</li> <li>· High income households</li> <li>· Number of students</li> <li>· Number of residents in dormitories</li> <li>· Total employment</li> <li>· Retail employment</li> <li>· Service employment</li> <li>· Other employment</li> <li>· Area in acres</li> <li>· Employment density</li> </ul>	<ul style="list-style-type: none"> <li>· Number of employees</li> <li>· Sales volume</li> <li>· Number of establishments</li> <li>· Population</li> </ul>	<ul style="list-style-type: none"> <li>· Number of households</li> <li>· Population and population density</li> <li>· Employment and employment density</li> <li>· Employment by sectors</li> <li>· Per capita income and household income</li> <li>· Population by age</li> <li>· Retail sales</li> </ul>	<ul style="list-style-type: none"> <li>· Total employment</li> <li>· Population</li> <li>· Earnings</li> <li>· Total personal income</li> </ul>	<ul style="list-style-type: none"> <li>· Population</li> <li>· Employment by sector</li> </ul>
<p>Self Sufficiency Indicators:</p> <ul style="list-style-type: none"> <li>· Employment and unemployment %, Economic activity participation rate (total, by gender, age, educated level)</li> <li>· Wage</li> <li>· Part-time and own-business employment</li> <li>· Income replacement rate (unemployment compensation, social welfare allowance)</li> </ul>					
<p>Equity indicators:</p> <ul style="list-style-type: none"> <li>· GINI index</li> <li>· Relative poverty ratio</li> <li>· Old people and Children poverty rate</li> <li>· Social welfare expenditures (inc. legal and voluntary private, and public social welfare expenditures)</li> <li>· Pension replacement rate</li> <li>· Housing prices</li> </ul>					

Source: Ministry of Health & Welfare. Social Indicators, 2008.

1. Some general indicators such as marriage, divorce, fertility, society cohesion, and health are excluded because of their irrelevance.

2. Cited from [Appendix B] in R. West, D. Rubin and J. C. Villa. Identification and Evaluation of Freight Demand Factors. *Final Report for NCFRP Project 11*, 2011.

# PARCEL FREIGHT DETERMINANTS IDENTIFICATION

## Selecting Socio-economic Indicators

Socio-economic factors this study uses are selected from the OECD social indicator and other indicators employed in several previous studies which examined the relationship between each socio-economic factor and freight traffic.

OECD categorizes social indicators into general, self-sufficiency, and equity indicators to manage each country's socio-economic statistics. This study utilizes their concept of some indicators for analysis. Socio-economic factors employed by Anderson and his co-authors are very useful for this study since their study focuses on socio-economic determinants to explain the freight transportation within a small and medium sized community. The spatial configuration of *Gu* which this study deals with is a medium sized analysis unit just as the Anderson study used. In fact, retail-related freight transportation such as parcel shipment is more common in a small and medium sized community. Therefore, their approach could be very applicable for this study.

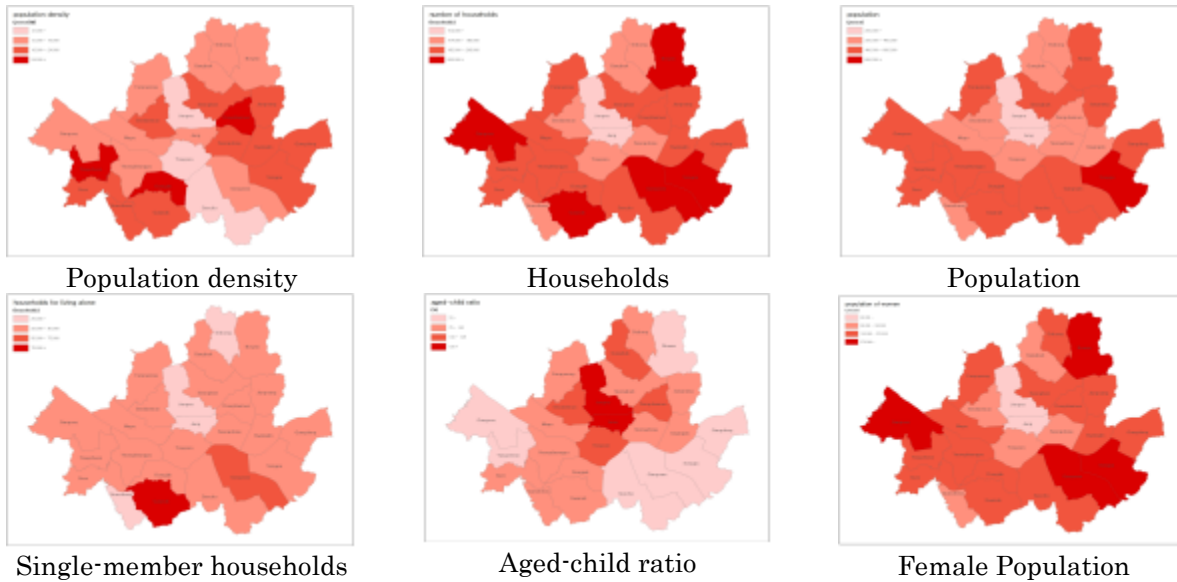
This study employs nineteen indicators as socio-economic factors to determine parcel freight in the City of Seoul. These nineteen indicators are categorized into four groups relating to population, income, industry, and housing, respectively. Since the City of Seoul does not publish any social inequality indicators by following the law of disclosure, some income-related indicators for certain regions are inevitably replaced by other alternative indicators.

**TABLE 2 Socio-Economic Factors Employed by this Study**

Categories	Indicators
Population Indicators	Population density, Households, Population, Single member households, aged-child ratio, Female population
Income Indicators	Number of rooms if more than six rooms, fiscal self-reliance ratio, house leasing price index
Industry Indicators	Manufacturing establishments, Manufacturing employment, Wholesale and retail establishments, Wholesale and retail employment
Housing Indicators	Numbers of detached houses, multiple-household houses, houses combined with business site, apartments, townhouses, multiplexes

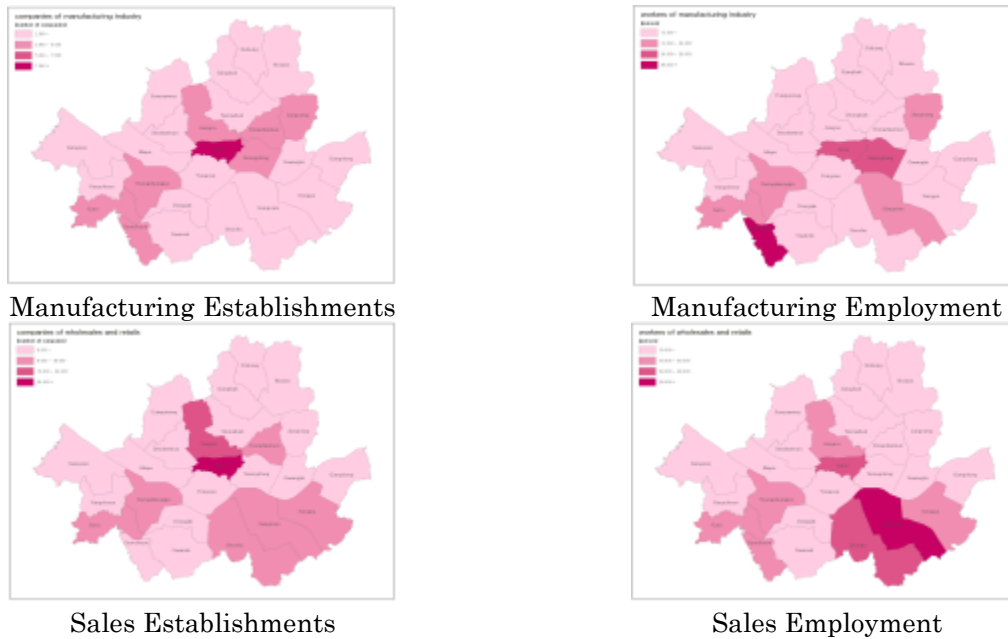
## Preview: Characteristics of Socio-Economic Factors

As of 2013, the City of Seoul is composed of 25 autonomous districts of *Gu* and 424 administrative *Dongs*, and its area is 605 square kilometers. The population density is 17,255 persons per square kilometers, which has remained since the late 1990's. However, the number of households has constantly increased: 3.45 million households in the late 1990's, 4.18 million recently in 2013. This change is related to the decrease in population per household and the rapid increase of households of the elderly.



**FIGURE 1 Maps Representing Population-related Indicators in the City of Seoul**

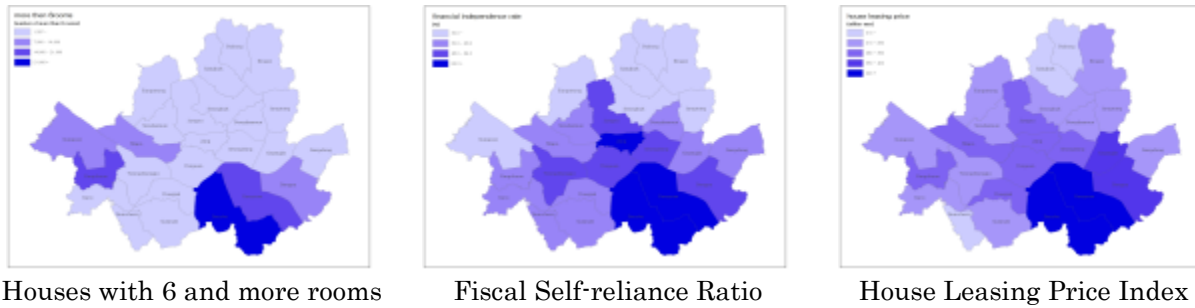
When examining the industry-related indicators, spatial concentrations of manufacturing and wholesale/retail within the City of Seoul are noted. In terms of the number of establishments, Jung-Gu is the hot spot with most manufacturing and wholesale/retail establishments. Manufacturing employees are mostly located in Geumcheon-Gu, secondly in Seongdong-Gu, and thirdly in Jung-Gu. While Gangnam-Gu is ranked second place in terms of number of wholesale/retail establishments, it is placed first in the number of employees in sales.



**FIGURE 2 Maps Representing Industry-related Indicators in the City of Seoul**

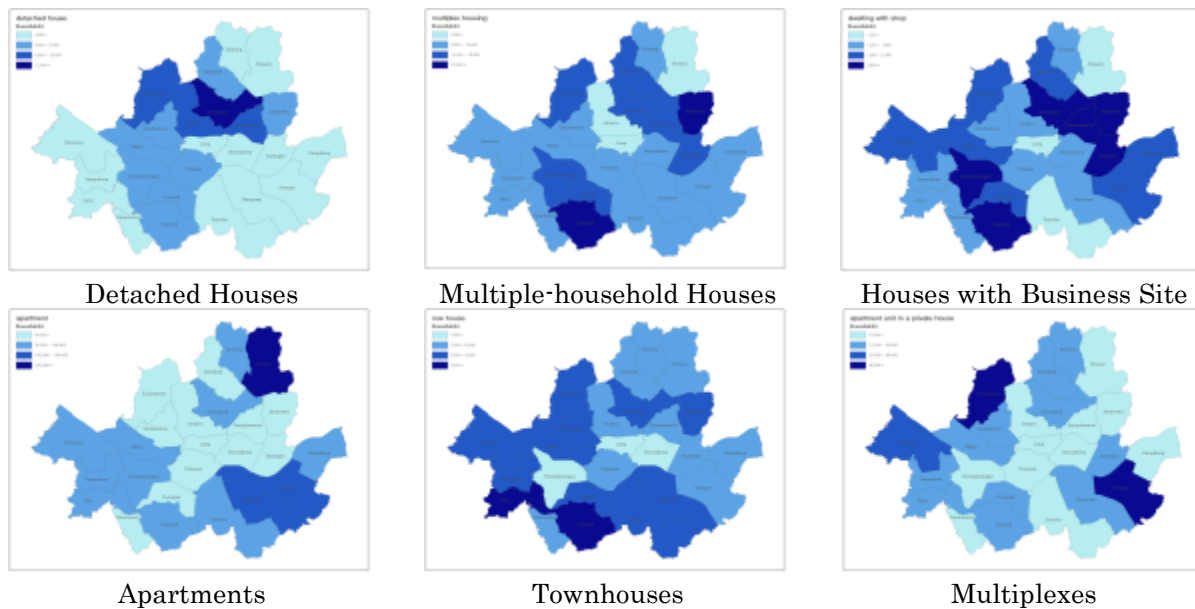


The number of houses with more than six rooms (indicating high-priced housing), fiscal self-reliance ratio, and house leasing price index are employed as income-related indicators. Seocho, Gangnam, Yangcheon, and Songpa *Gus* are ranked in this order in terms of numbers of houses with six and more rooms. As for the fiscal self-reliance ratio, Gangnam-Gu is the first with 75.9%, and followed by Seocho, Jung, Jongno *Gus* in order. Gangnam-Gu also represents the highest house leasing price index of about 438 thousand dollars (460 million won), and then Seocho and Songpa are placed in second and third, respectively.



**FIGURE 3 Maps Representing Income-related Indicators in the City of Seoul**

There are also distinctive differences in housing characteristics among each *Gus*. The most popular housing type in Seoul is the apartment of 1.5 million households, intensively located in the northeast, southeast, south, and west of the city. Detached houses of typical housing in Korea are usually concentrated in the northern part of the city while multi-household houses are in the east and south of the city. Housing combined with business sites is another type of housing in the City of Seoul, which is mainly situated in Gwanak, Yangcheon, Jungrang, Seongbuk *Gus*. There are more townhouses in Guro and Gwanak *Gus*, and multiplexes are in Songpa and Eunpyeong *Gus*.



**FIGURE 4 Maps Representing Housing-related Indicators in the City of Seoul**

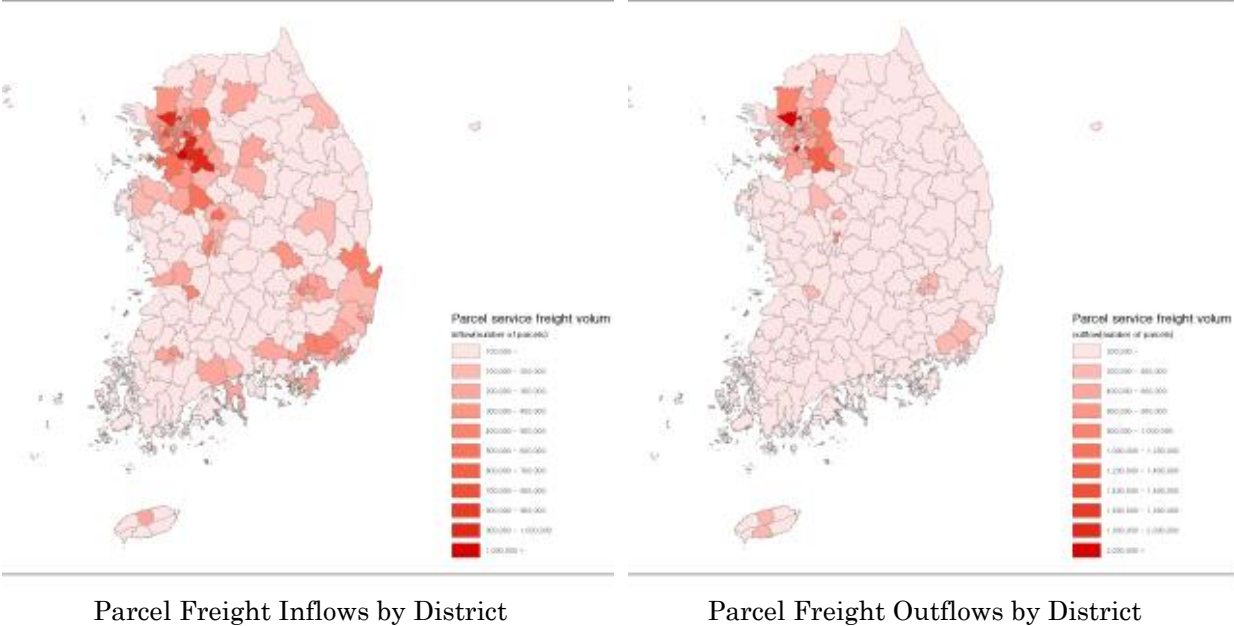
According to four socio-economic indicators, each autonomous district of *Gu* within Seoul shows spatial differentiation in population and economic structures. It is because Seoul had experienced radical urban development and rapid economic growth since the 1970's, and the outcomes of such changes have been distributed discriminately by *Gu*. Hence, this study explores the relationship between each district's socio-economic characteristics and parcel freight productions/attractions. It also examines what parcel service-related city logistics policy to develop that is specific to each region and how to implement this regionally differentiated policy and strategies for each region more effectively within the City of Seoul.

## ANALYSIS AND RESULTS

### Characteristics of Parcel Freight Flows in Seoul

The volume data of parcels shipped by *Gu* is based on the parcel freight OD data for the year of 2013 provided by *Company C*, one of the major parcel service companies in Korea.

Parcel freight attracted to the City of Seoul from other regions in Korea accounts for 24.22% of the entire inflows transported by *Company C*, while freight flows Seoul produced in 2013 explains 30.3% of the entire outflows by *Company C*. Parcel freight volume transported intra-regionally within Seoul is also around 40.38% of the entire volume.

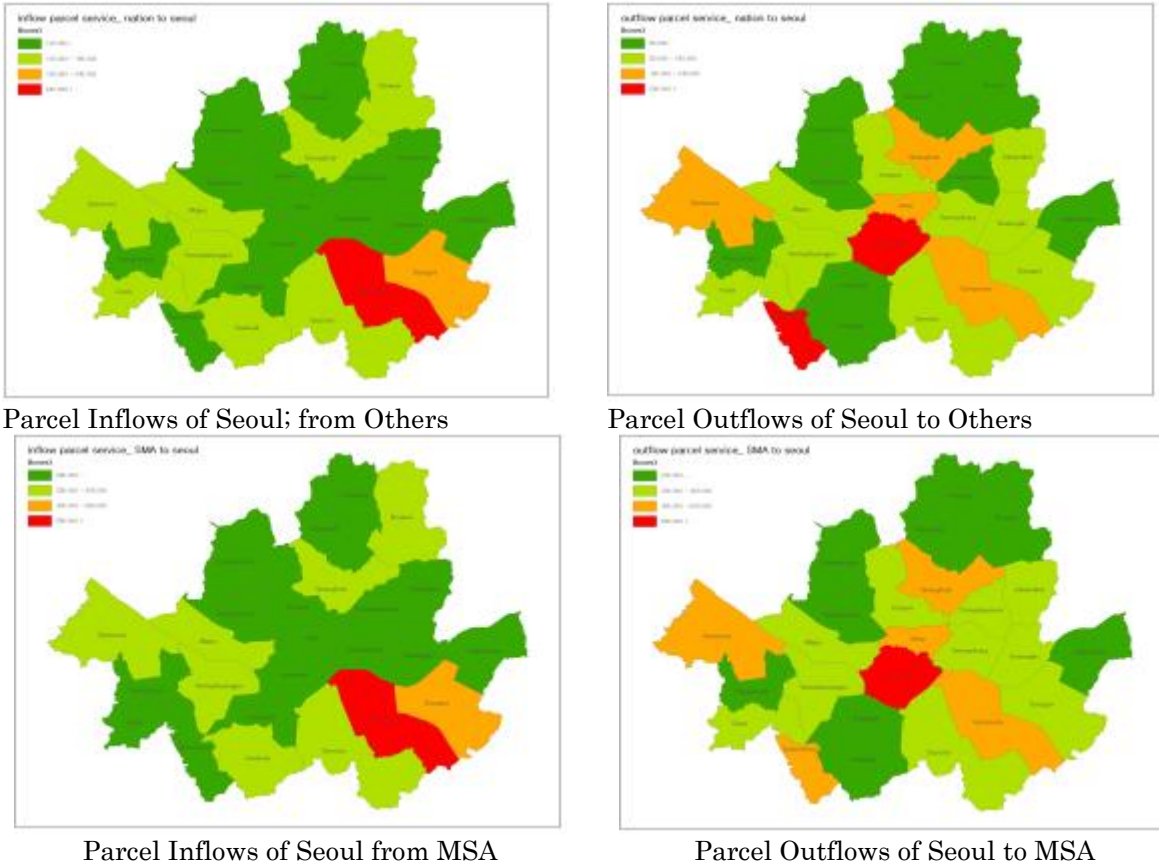


**FIGURE 5 Maps of Interregional Parcel Movement**

The volume of inflows to Gangnam-Gu is the highest and reaches almost 653 thousand boxes. Out of that number, 275 thousand boxes, which occupy about 42% of the entire inflows, are from the Seoul Metropolitan Area (SMA, covering the cities of Seoul and Incheon, and Gyeonggi-Do). Yongsan-Gu produces the most outflows of 707 thousand boxes, and

agglomeration of major distribution centers in this district could explain this about parcel outflows. Around 43% of the outflows from Yongsan-Gu are shipped to the SMA.

Parcel flows by district show the regional differentiation just as the socio-economic indicators for each district did in the previous section. The following section examines how related the parcel flows by district ('Gu') are with its socio-economic characteristics in order to suggest the regionally specific city logistics policy for parcel services in the conclusion.



**FIGURE 6 Maps of Parcel Freight Movements between Seoul, SMA, and the rest of Seoul**

## Relationship between Socio-Economic Indicators and Parcel Freight Flows

### Correlation Analysis

Spearman correlation coefficients (Rho) for 25 districts in the City of Seoul are calculated to analyze the relationship between socio-economic indicators and the volume of parcel freight flows. The calculation is made for two sets: one is for nineteen socio-economic indicators with parcel inflow freight, and the other is for nineteen indicators with outflows for each district.

Correlation between parcel freight inflows and each socio-economic indicator category indicates which socio-economic factors have an influence to determine the parcel freight productions and attractions by district. Out of population-related indicators, population size, number of single-member households, and female population size have positive correlations, while aged-child ratio has negative correlation with parcel freight inflows. This implies that

regions with more single-member households and a higher female population but less elderly people consume more parcel services. On the other hand, little correlation between parcel freight outflows and population-related indicators are revealed.

Alike the population-related indicators, housing-related indicators are also correlated to parcel freight inflows for each district. In particular, the apartment index has strong explanatory power to determine the parcel freight inflows with a statistically significant positive correlation coefficient. However, this index is rarely correlated to outflows.

However, the numbers of employees and establishments show strong positive correlation with parcel freight flows that each district produces. In detail, manufacturing employment, wholesale/retail employment and establishment are positively correlated with outflows at the significance level of 0.01, whereas so is manufacturing establishment at the significance level of 0.05. As for the parcel freight inflows, wholesale/retail employment and establishment show positive correlation at the significance level of 0.05. It indicates that wholesale/retail focusing on sales and distribution produces and attracts parcel freight flows at the same time, while manufacturing mainly produces parcel freight flows from the region to the others.

One of the alternative income-related indicators, number of houses with six and more rooms shows a strong positive correlation with parcel freight inflows. Fiscal self-reliance ratio shows a positive correlation with outflows at the significance level of 0.05. House leasing price index has a negative correlation with parcel freight inflows at the significance level of 0.05.

**TABLE 3 Socio-Economic Factors Employed by this Study**

Classification		Inflows	Outflows
<b>Population – related Indicators</b>	Population density	-.282	-.387
	Number of households	.248	-.226
	Population size	.593**	-.064
	Number of single-member households	.537**	-.143
	Aged-child ratio	-.612**	-.010
	Female population size	.728**	-.201
<b>Housing – related Indicators</b>	Number of detached houses	-.326	-.206
	Number of multiple-household houses	-.267	-.261
	Number of houses with business site	-.149	-.151
	Number apartments	.705**	-.026
	Number townhouses	.301	-.321
	Number multiplexes	.206	-.386
<b>Industry – related Indicators</b>	Number of manuf. Establishments	-.108	.503*
	Number of manuf. Employees	.093	.607**
	Number of sales establishments	.476*	.657**
	Number of sales employees	.501*	.630**
<b>Income – related Indicators</b>	Number houses with six and more rooms	.737**	.123
	Fiscal self-reliance ratio	.365	.448*
	House leasing price index	-.520*	-.158

\*\* The corresponding correlation coefficient is statistically significant at the significance level of 0.01.

\* The correlation coefficient is statistically significant at the significance level of 0.05.

In a word, all four socio-economic indicators play a role as determinants of parcel freight inflows, whereas only industry-related indicators have an influence on parcel freight outflows.

### Regression Analysis

Multiple regression analysis is conducted in order to identify socio-economic factors determining the volume of parcel freight inflows and to measure their explanatory power. The regression is made with six variables that are proven statistically significant at the significance level of 0.01.

Regression model is concluded to be statistically significant, and three variables out of six are shown statistically significant at the significance level of 1% or 5%. The three variables are number of single-member households (population-related indicator), number of apartments (housing-related indicator), and number of houses with six or more rooms (income-related indicator).

**TABLE 4 Regression Analysis Results**

<b>1) Statistical significance of multiple regression on parcel freight inflows (INFLOW)</b>					
	Degree of Freedom	Sum of squares	Mean square	F-ratio	Significant F
Regression	6	2.19829E+11	36,638,088,200	16.8	0.000
Residual	18	39,201,965,406	2,177,886,967	-	-
Sum	24	2.5903E+11	-	-	-
<b>2) Regression results summary</b>					
	Coefficient	S.E.	t statistics	P-value	
Y intercept	59,310.39	144,544.46	0.41	0.69	
POPULATION	0.06	1.05	0.06	0.95	
1-MEMBER HOUSEHOLDS	2.78	1.07	2.60	0.02	
AGED-CHILD RATIO	472.44	1,016.36	0.46	0.65	
FEMALE POPULATION	- 0.52	1.97	- 0.26	0.80	
APARTMENTS	1.44	0.54	2.67	0.02	
HOUSES W/ 6+ ROOM	12.67	2.47	5.14	0.00	

The model with three significant variables mentioned above was developed after excluding three insignificant variables is as follow:

$$\text{INFLOW} = 89,917.49 + 2.15 \times \text{1-MEMBER HOUSEHOLDS} + 0.73 \times \text{APARTMENTS} + 11.97 \times \text{HOUSES W/ 6+ ROOMS} \quad (1)$$

Another multiple regression is carried out for identifying determinants of parcel freight outflows with three variables of significance at the level of 0.01. The model is proven statistically significant at the significance level of 0.05, but only one variable of the number of manufacturing employees appears significant. The model finally developed is:

$$\text{OUTFLOW} = 195,201.45 + 8.44 \times \text{MANUF EMPLOYMENT} \quad (2)$$

This result indicates that the volume of parcel freight outflows is affected by the employment size of manufacturing instead of its number of establishments.

## CONCLUSIONS

### Potential policy recommendations

This study identified the freight production and attraction determinants through correlation and regression analyses between various socio-economic variables and parcel freight flow volumes, and explores the spatial patterns of parcel freight flows' OD. This study concludes that each district has its own socio-economic characteristics which affect the productions and attractions of parcel freight. It implies that city logistics policy needs to reflect each district's diverse socio-economic characteristics as well as the approach in a general view.

Correlation and regression analyses executed in this study aimed at understanding diversified characteristics for each region and the results could help policy makers and planners to diagnose and evaluate current conditions, and to develop new logistics policy to promote more sustainable parcel services within the city. The analysis results present that single-member households and higher income households consume more parcel services, and more parcel freight flows are attracted to highly dense residential areas such as apartment complexes. Basically, more attention on planning and developing city logistics policy to support parcel services is required for these regions with stronger potential to consume more parcel services. At a more detailed level, specifically differentiated parcel service-supportive logistics policy can be devised to accommodate each district's socio-economic settings.

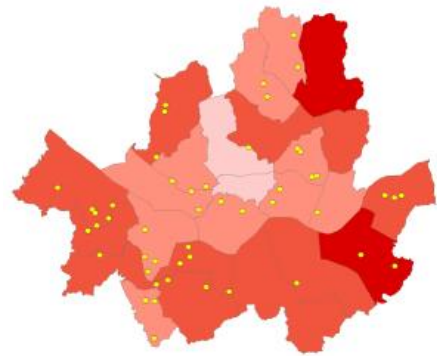
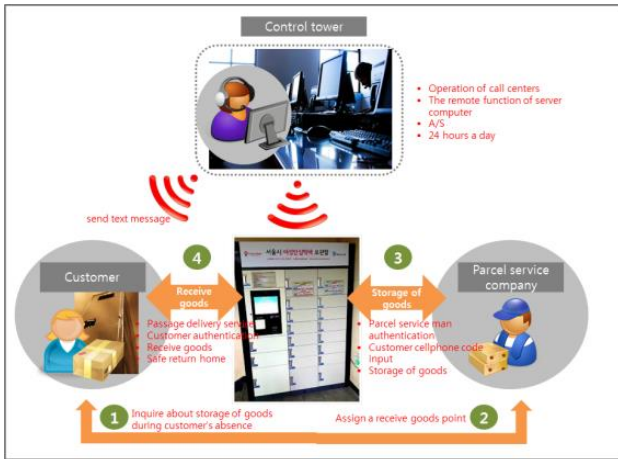
For instance, apartment complexes located in a highly dense residential area attract more parcel services so they also suffer from parking problems, congestion, road safety and pollution issues within the complexes. To solve these problems, a consolidation center for parcel storage and delivery is proposed. Unmanned parcel lockers are also another popular alternative that can be introduced when the actual cooperation between other parcel service companies is not realistic. Unmanned parcel storage lockers are made to reduce truck trips, prevent crime, and minimize the delivery return during the absence of recipients.



**FIGURE 7 Unmanned Parcel Storage Lockers**

One case also offers improvement directions to another case. Highly dense apartment complexes attract more parcel services not only since they have a large population size but also since the apartment complexes usually run their own consolidated storage and distribution points so as to enhance the convenience of parcel services. The latter implies that one of the essential approaches to promote parcel services demands for the district with large coverage of traditional detached houses is to install consolidated distribution points and unmanned parcel storage lockers. In particular, for the district with more single-member households such as campus towns, more parcel distribution and storage points are required so as to reduce the delayed and missed deliveries caused by returned shipment since there is no recipient during daytime.

In addition, analysis results show that more parcel freight inflows occur in locations where more women reside. It is because female customers are leading the growth of sales through e-commerce. However, female customers are quite vulnerable to parcel delivery-related crimes. For this reason, regions with higher female population ratios have priority to be invested in the safe parcel service project for women using unmanned parcel lockers. In fact, although Nowon and Songpa *Gus* have large female populations, the survey and analysis results indicate the safe parcel project for women has rarely been developed and planned in those two districts. It points out the mistake of current policy and makes them first for future investment.



Locations of installed safe parcel lockers

**FIGURE 8 Safe Parcel Delivery Services for Women**

Analysis results related to parcel freight outflows also direct policy makers and planners to develop more practical city logistics policy for parcel services. More attention should be paid to planning and implementing the policy and strategies to facilitate the management of parcel freight outflows in the regions where manufacturing and sales business are agglomerated. *Dongdaemun Market* is the typical example, which is the fashion cluster where the most wholesalers and retailers of garments, approximately 35 thousand stores and 150 thousand participants, are concentrated. This market is troubled over the matters such as lack of loading/unloading zones and parking spaces, illegal road occupation, and pedestrian safety issues. Although bikes have been developed spontaneously as the representative transportation mode which adapts to the congested and crowded road conditions of this area, a comprehensive approach is still needed to solve the problems. Installing a logistics consolidation center and exclusive freight loading/unloading zones are required with the highest priority.





**FIGURE 9 Logistics Conditions of Dongdaemun Market in Seoul**

## REFERENCES

1. The Korea Chamber of Commerce & Industry. *A study on the Parcel Service Industry Market Conditions*, 2013, Seoul.
2. Ministry of Gender Equality & Family. *Fear of Criminal Victimization*, 2011, Seoul.
3. Statistics of Seoul Metropolitan Government. [stat.seoul.go.kr](http://stat.seoul.go.kr). Accessed March 15, 2014.
4. Department of Urban Planning Bureau in Seoul Metropolitan Government. *Trend of Real Estate Market in Seoul*, Vol.78, 2013.
5. Sung-youll Lee, Young-han Park and Jung-min Park. The Development of a Shortest Route Search Demonstration System for the Home Delivery Using Ant Algorithm: Limiting to Yangyang Province. In *Korea Society of Industrial Information Systems*, Vol. 12, No. 4, 2007, pp. 89-96.
6. Dong-kyu Kim. A Study on Construction of Local Parcel Service Network through Collaboration with Manufacturing Sector. In *Proceedings of the Korea Safety Management & Science Spring Joint Meeting*, 2011, pp. 379-384.
7. Sera Song. A suggestion of rebuilding vehicle routing system strategies of urban area. In *Postal & Logistics Technology Review*, Vol. 9, No. 4, 2010, pp. 110-116.
8. Sang-gil Lee and Yong-jin Kim. Environmental and Financial Effect Analysis of the Home Delivery Service Reconsigned to Apartment Resident. In *Transportation Technology and Policy*, Vol. 7, No. 5, 2010, pp. 49-60.
9. Ji-don Yu, Yu-jun Choi and Ik-sun Lee. A Study on the Logistics Policy Considering the Cost of Carbon Emission in Parcel Express Industry. In *The Korean Operations Research and Management Science Society*, Vol. 29, No. 2, 2012, pp.157-165.

10. The Seoul Institute. Seoul City Logistics Policy Plans and its Strategies, 2009, Seoul.
11. The Seoul Institute. A Study on Improvement Strategies for Freight Facility through Urban Rearrangement Project for the City of Seoul, 2006, Seoul.
12. West, R., D. Rubin and J. C. Villa. Identification and Evaluation of Freight Demand Factors. In *Final Report for NCFRP Project 11*, 2011, Washington, D.C.
13. Anderson, M.D., J.P. Wilson and G.A. Harris. Using OD Estimation Techniques to Determine Freight Factors in a Medium Sized Community. In *Journal of Transportation Technologies*, Vol. 3, No. 1, 2013, pp. 39-43.
14. A. Devan. *Macroeconomic Factors of the Package/Parcel Delivery Industry*, 2010. Yahoo Contributor Network.
15. Ministry of Health & Welfare. *2008 OECD Social Indicators*, 2009, Seoul.

### **Acknowledgment**

This research is supported by the Volvo Research and Educational Foundations through the MetroFreight Center of Excellence, KOTI. Data was provided by one of the major parcel delivery service companies in Korea. All errors and omissions are the responsibility of the authors.